TEXTBOOK
OF
FIREARMS INVESTIGATION, IDENTIFICATION and EVIDENCE

J. S. HATCHER

TEXTBOOK

OF

FIREARMS INVESTIGATION, IDENTIFICATION and EVIDENCE

J. S. HATCHER

Copyright 1935

By

Small-Arms Technical Publishing Co.

First Printing, 1935
Second Printing, 1940
Third Printing, 1942
Fourth Printing, 1943

PRINTED IN U. S. A.

FOREWORD

Publications on the identification of firearms, a subject so vitally important to modern law enforcement and prosecution, have in the past been inadequate in scope, and consisted largely of scattered articles, published in the various peace officers' and technical journals, each article dealing with only a limited phase. Further, these articles were always difficult to obtain, and more difficult to search for some desired point.

Hence Major J. S. Hatcher's book, "Firearms Identification," is particularly welcome, and a pre-reading of its chapters indicates that he has produced just what I was confident he would, a comprehensive, accurate treatise.

Major Hatcher is well able to produce an authoritative book, for he has long been recognized as a conscientious, capable, and scholarly expert. I am proud that he has co-operated in the work of the Federal Bureau of Investigation by serving as a member of its training school faculty, giving newly-appointed Special Agents the benefits of his theory and practice. The manner in which these men have grasped his instruction shows that he not only knows the subject of firearms identification, but can present his ideas well.

By its meticulous emphasis of every important detail, this book should do much to discourage that dangerous practice of recent years wherein law enforcement agencies purchase microscopes and expect the fingerprint experts in their departments to overnight become experts in the analysis of firearms evidence, and to carry on such work in their spare time. At the same time it should do much to impress upon these law enforcement agencies the great importance of the proper evaluation of firearms evidence in criminal cases by an impartial expert who devotes his full time to mastering the intricacies of this science. Expert testimony on the subject has been sufficiently tried in the courts to clearly establish its value when prepared by an honest technician, fully qualified in the science and appreciative of its limitations when the quantum of available data concerning the evidence is not sufficient. In crimes where firearms have been used, expert analysis of the resulting evidence is as essential to the investigation as the questioning of witnesses or any other phase of the inquiry made by a thorough investigator.

Major Hatcher's volume will be welcomed by both the conscientious student and the expert. The orderly arrangement of his material seems admirably suited, either as a logical sequence of study or for ready reference by the expert. In readily understandable statements he explains much of the bewildering terminology descriptive of the great variety of ammunition and weapons which are now, or have been on the market in recent years. From years of association with, and research into the many ramifications of the entire subject of firearms, the author is particularly well qualified to arrange the problems in a logical order and to properly determine the amount of attention best given to each.

Although indisputably a technical treatise, the book makes tremendously interesting reading and should be particularly fascinating to that great army of "gun cranks" who find the study of firearms and their loads an intriguing hobby. The Judiciary will find it an instructive reference work and an authoritative one.

J. EDGAR HOOVER,
Director.

INTRODUCTION

In cases of death by shooting, it frequently happens that the life or liberty of a suspected person may depend entirely upon the ability of the authorities to determine what kind of weapon did the shooting, or whether a fired cartridge or bullet involved in the fatality did or did not come from a certain gun. The knowledge of firearms and explosives and how they act, that is possessed by the public at large, including most peace officers and members of the legal profession, is so meagre that almost unbelievable mistakes in testimony vitally affecting the guilt or innocence of an accused person are continually occuring.

During the past twenty or more years, the author has had occasion to observe many instances in which the apprehension of some individual responsible for a crime with firearms or explosives has been delayed or rendered impossible by the lack of even a small amount of knowledge of the right kind by the detectives or police who made the investigation. He has observed other instances in which attorneys, courts and juries have been imposed on or misled by insufficiently informed or unscrupulous individuals who have managed to qualify as expert witnesses on firearms. The unfortunate fact that members of the legal profession may have been imposed on in this manner is small cause for wonder, in view of the fact that the subject of firearms and explosives is a large and highly specialized one, the many technical details of which can ordinarily be known only to those who for some reason have had experience with firearms and studied them extensively.

Thus a practical knowledge of guns and explosives is of immense value in certain phases of police and legal work, but it is not all that is now required, for modern methods of cartridge and bullet identification depend upon highly scientific methods involving the use of the comparison microscope and other laboratory apparatus in the solution of the problem.

With the increasing application of these scientific instruments and methods, the practice of firearms identification is assuming an ever increasing importance and prestige, and the time has now arrived when no police or detective force can afford to be without its firearms expert; and no trial judge, district attorney, or attorney engaged in the practice of criminal law can afford to be without a knowledge of the principles involved, as well as of the correct firearms terminology. It certainly does not enhance the reputation of any member of the legal profession amongst those of his hearers or possible clients who are acquainted with firearms, to hear him making some of the common errors such as speaking glibly of how the "bullet exploded" when he obviously refers to the cartridge, or to hear him ask if the defendant "cocked the trigger;" and it is highly important for the success of his case for him to know what any expert witness is talking about, and to be able to recognize instantly any inaccuracies in the testimony, or any manifestly absurd statements made by the witness. It may at any time be useful to know what kind of pertinent evidence a firearms expert may be able to uncover, so as to avoid overlooking any possibilities of obtaining material that may be useful to him in presenting his case.

In preparing this book covering both practical firearms investigation and the more advanced and specialized scientific identification of fired bullets and cartridges, the purpose of the author is to be of the maximum assistance to the cause of justice by providing an accurate textbook on these subjects for those who desire to practice this work, as well as a comprehensive reference book for members of the legal profession and others who may have use for such a volume.

Though the author cannot lay claim to any artistic talent, he has endeavored as best he could to illustrate many of the points discussed in his text by the use of free-hand sketches in pen and ink, as these often allow a certain point to be brought out much better than it can be done by a photograph. This is because the very points that it is desired to impress upon the reader can be accentuated by the pen, though the camera might fail to show them at all. In referring to these sketches, the reader should bear in mind that it has been considered desirable to accent or exaggerate somewhat the important points of the illustration, in order to convey a clear idea of what to look for. Sketches such as those of the firing pin imprints on page 260 or of the characteristic marks left on fired cases, shown on pages 261 and 263 are examples. In actual practice, the samples under observation would rarely, if ever, show such pronounced markings as those indicated in these sketches, especially when viewed by the naked eye.

In preparing his text, the author has purposely omitted any mention of the various things which a criminal may do to his gun, either before or after the commission of a crime, to render the work of identification more difficult. It is fully expected that this book may be criticized by some readers as being incomplete because these questions are not discussed; but it has been considered to be the better policy not to make public knowledge that may be used as an aid in evading justice. Fortunately, the things of this kind that a criminal may attempt will usually enable the expert to know that the arm has been tampered with for no good reason, and this very circumstance in itself carries a presumption of guilt or criminal intent.

Because pistols or revolvers are the weapons that are most often involved in shooting cases, a knowledge of these arms, their ammunition, ballistics and use is essential to a thorough understanding of firearms investigation and identification, and for that reason it has been thought advisable to incorporate in one volume with this book the author's TEXTBOOK OF PISTOLS AND REVOLVERS, which has also been published separately for the use of those who are interested only in shooting. The binding of both of these books as a unit is considered to be the proper and logical procedure, because the worker who becomes to any large extent interested in firearms identification will have constant use for much material not now available except in the TEXTBOOK OF PISTOLS AND REVOLVERS.

Annapolis, Maryland.
February, 1935.

TABLE OF CONTENTS

1. The Firearms Expert and the Courts 1
2. Elementary Principles of Firearms 21
3. Elementary Principles of Ammunition 66
4. Powders and Explosives 96
5. Firearm, Cartridge and Bullet Markings 135
6. Instruments and Equipment 156
7. Preliminary Firearms Investigation 195
8. Advanced Firearms Identification 248
9. Digest of Court Decisions on Firearms Identifications 294
10. Bibliography 312
11. Reference and Conversion Tabulations 325

CHAPTER 1

FIREARMS EXPERTS AND THE COURTS

IT very often happens that the decision in a court case in which shooting is involved depends very largely upon the testimony of one or more expert witnesses of firearms. Sometimes the expert is called by the prosecution, other times by the defense; and at still other times, particularly in the past, before the present scientific and accurate methods of bullet and cartridge identification had been developed, it frequently happened that self-styled "experts" were introduced by both sides, and the court and jury were treated to the spectacle of two supposedly infallible experts disputing each other by giving conflicting testimony, as still sometimes happens in cases involving handwriting.

Such performances certainly do not tend to give the public or the courts any great confidence in the value of this kind of testimony, so it is fortunate that in late years the application of scientific methods and instruments to the accurate identification of bullets and cartridge cases has reached such a state of development that it frequently is possible, by the aid of the microscope and of enlarged photographs, to show *exactly* what happened, without the slightest chance for a difference of opinion. In one such case, the State's attorney, (who by the way, is now the Attorney General of the United States), himself recommended a nolle prosequi of the case after he had seen from a comparison of the murder bullet with one from the defendent's gun, that they did not match. For further details of this case, see page 299. This substitution of clearly demonstrable fact for mere opinion has greatly strengthened the value of expert testimony in firearms cases, and has created a marked change in the status and prestige of the expert in this line.

This subject is ordinarily thought of primarily in connection with criminal cases, but in late years particularly, there have been more and more instances of civil suits for personal damages arising from some incident or accident connected with the use of firearms. Suits of this kind are increasing in number, and offer a fertile field for the services of the expert. They may involve some failure of material, such as the bursting of a gun, which is very often the fault of the user, but which is likely to result in a suit against either the maker of the gun, or of the cartridge, or of both; or from the accidental or intentional wounding of one person by another, in which case the user of the gun may very properly find himself the defendent in a damage suit, even though he is relieved from criminal responsibility. In still another class of cases the proprietor of a shooting gallery may be sued for some injury to one of his patrons, or a gun club or shooting organization may be sued for an injury sustained by a range attendant or some other person on the range; or possibly to some person who may not even be on the range, as in cases which have happened in the past where a bullet has for some reason been allowed to go wild and strike a dwelling or individual in the neighborhood.

Firearms and explosives act in their own peculiar and characteristic way, which may seem simple enough to those who are familiar with such things, but in regard to which the public in general, including many of the police, are almost completely uninformed. For this reason, individuals who have had even a moderate experience with firearms and explosives frequently have sufficient special knowledge of this kind to enable them to give a final answer to questions on which the authorities may be totally in the dark. An example of this is the case of an individual who was mysteriously shot with a .380 automatic pistol bullet.

A man who happened to be in the vicinity of the shooting was arrested because he was found to possess a .380 caliber Colt automatic pistol which had recently been fired. Things looked very serious for him until one of his friends who was interested in firearms heard of the case and began to investigate it. On examining the bullet taken from the body of the victim, this friend observed that there were seven rifling grooves on the bullet, and he happened to know enough about firearms to realize all Colt automatic pistols have six grooves and that the only .380 automatic pistol made in this country with seven grooves is the Remington. When this fact was pointed out to the authorities they released the prisoner and began looking for the owner of a Remington pistol, with the result that the real murderer was soon apprehended.

There is little doubt that the first prisoner would have been convicted of a crime of which he was entirely innocent if he had not been fortunate enough to have had a friend who took more than the usual interest in guns.

In another case a bullet recovered from the victim was a .45 caliber metal jacketed bullet, the type used in the government model automatic pistol. It did not take long for the police to find a suspect who had a .45 caliber automatic pistol in his possession and it probably would have gone hard with him if it had not been for the fact that a firearms expert was available who pointed out that the Colt automatic pistol has rifling with a left-hand twist, whereas the bullet in question showed right-hand rifling marks. The expert advised the authorities that the shooting was done with a Smith & Wesson Model 1917 revolver which shoots the same cartridge as the automatic pistol but which has a right-hand twist.

These examples, which might be multiplied by the hundred, illustrate the very great service to the cause of justice that can be rendered by even a moderate knowledge of firearms. The information rendered in these cases did not require any deep or abstruse knowledge or any special apparatus. It required only the ordinary knowledge that any alert user of firearms might possess.

[There are, however, many problems occurring in connection with criminal cases in which the answer, while apparently very difficult to obtain, is really quite simple provided there is available one of the several scientists who now make firearms identification their specialty. These men have records available of the specifications and characteristics of practically every firearm that has ever been made and they also have elaborate and delicate instruments constructed especially for firearms identification. Moreover, they also have years of experience and study on this subject.]

✓ Without this experience as well as access to the records and instruments referred to above, no man is fully equipped to qualify as a firearms identification expert. Unfortunately, it is only in recent years that such experts have been available, and a few years ago almost anybody with a slight smattering of small arms knowledge and a plausible manner could get up before a jury as an expert witness and either swear away the life of the accused or else throw a monkey wrench in the wheels of justice at fifty dollars a day and expenses. Fortunately the individual whose main equipment is a pocket magnifier and a footrule plus unlimited gall, is finding it increasingly harder to be permitted to qualify as an expert on this subject.

A case of this kind is described as follows by R. E. Herrick in *Arms and the Man* for May 15, 1923:

"The accused secured the best legal talent that could be found, and the prosecuting attorney bestirred himself to make his case as nearly impregnable as he could humanly hope to do.

"To bolster his case Mr. Prosecuting Attorney employed the services of an expert (self-styled) on firearms and ammunition. This man is the operative of a large, well-known detective agency.

"It was brought out in the cross-examination of this expert that he had secured a certain bullet found on the floor of the cellar, and another one from the inside lining of the coat worn by the deceased at the time of the killing. He had secured the revolver belonging to the accused and had recovered several bullets fired from this gun and by means of a magnifying glass and a so-called 'micrometer' had determined that the bullet found in the deceased man's coat had been fired from the gun admittedly belonging to the accused.

"One of his tests had been to cut off the jacket of the bullet to note the effect of the lands of the barrel on the soft lead beneath. Just what he expected to find there I cannot imagine. Perhaps he expected to find some sort of magic photograph showing the image of the fifty dollars per day he was getting for his 'expert' testimony. I suspect it was merely hocus pocus.

"His magnifying glass used for comparing indentations on the recovered bullets, was, as I remember, either a single or double lens pocket magnifier. His micrometer caliper was nothing more or less than a Starrett inside and outside caliper rule, graduated down to 1/64″. And on the readings of such instruments as these, this 'expert' on firearms and ammunition was willing to swear a man's life away at the rate of fifty dollars per day.

"I would like to hear the roar that would go up if the Ordnance Department sent out National Match Springfields accompanied by star gage records reading something like this: 19.5/64″, 19/64″, 19/64″, and so on."

In this case Mr. Herrick, who was president of the Boise Rifle Club, was called by the defense and I will quote further from his article as follows:

"One amusing incident occurred during cross-examination of the 'expert' by the defense. The witness was asked to show the jury the instrument used to measure these bullets. The witness passed over said caliper. The questioner took it, examined it a moment, held it up and exclaimed, 'Why this is not a micrometer, this is a monkey wrench,' much to the amusement of the spectators.

"Major Hatcher would do well to get this 'expert' on his staff at Frankford Arsenal, for see how complete is his knowledge of the manufacture of firearms:

"Question by defense attorney: 'Mr. G., have you ever spent any time in a factory where revolvers are made?'

"Answer: 'Yes, sir. I have been through Browning Bros. Plant.'

"Question. 'Explain to the jury how revolver barrels are made.'

"Answer: 'They are cast in moulds.'

"Shades of Samuel Colt and of Eliphalet Remington! Such 'expert' testimony in a trial wherein twelve good men and true are to decide whether a fellow man is not guilty of the crime of murder. If that sort of testimony is worth fifty dollars per day then a hodcarrier who knows his business should receive remuneration at a rate of not less than $5,000 per day."

This case is merely one of a number of similar or even more flagrant ones that have come to my attention. In one case in New England a man was actually convicted and sentenced to death but afterward given a new trial and acquitted when a member of a revolver club became interested in the case and developed the fact that in spite of magnifying glass and micrometer, the "expert" in this case had failed to notice that the bullet had six grooves whereas the defendant's gun had only five.

The Famous Stielow Case

The present science of firearms identification as it exists in this country may be said to have its origin in the notoriety aroused by a gross miscarriage of justice in New York State. One C. E. Waite, formerly an operative in the Department of Justice, became interested in this case and started work along this line which since his death has been ably carried on by Colonel Calvin Goddard and others.

At daybreak on March 22, 1915, Charlie Stielow, an illiterate, good-natured tenant farmer, on going out of his house discovered a woman in her nightdress lying dead on his doorstep, shot through the heart. Her footsteps in the light fall of snow led from the nearby house of Charles B. Phelps, the owner of the farm.

The dead woman was housekeeper for the aged Phelps who was reputed to keep large sums of money in the house. Stielow found the kitchen door of the Phelps house open, a bullet hole in the glass and his employer, a man of seventy, unconscious on the kitchen floor with three bullet wounds in his body. A lighted lamp was burning low on a nearby table. Stielow at once ran to a neighbor's house and gave the alarm. It was quite evident that robbery was the motive, as the bureau where Mr. Phelps kept his money was rifled and his wallet was missing.

The murder was committed in a small rural community, and the local authorities, unused to coping with such crimes as homicide had allowed the curious crowd to trample the foot prints and destroy most of the clues before any real constructive work was done toward solving the mystery.

Stielow lived in the tenant house with his wife and two children, his wife's mother and his wife's brother, Nelson Green. The shooting had been done with a .22 caliber firearm and both Stielow and Green swore at the inquest that neither had a gun of any kind, but it turned out later that Stielow owned a cheap .22 caliber revolver and a .22 caliber rifle and that he had given these guns to a younger brother-in-law to hide.

After ten days had elapsed without any progress Nelson Green was arrested and at two o'clock the next morning detectives secured his signature to his confession that Stielow and he had committed the murders. Stielow was thereupon arrested and held in jail separately from Green. He made a request to be allowed to talk to his wife as he said he had a heavy burden on his soul. He was, therefore, accused of the crime and as is not unusual in such cases, he also finally confessed.

The two confessions checked generally, though neither told anything that was not common knowledge to everybody who had been in the vicinity, except that each man accused the other of instigating the crime and firing the fatal shots. The confessions stated that they had planned to rob Phelps and had waited outside until he was in bed, then rapped on the kitchen door and shot him down when he answered the knock. As they went toward the bedroom where they expected to find the money, the housekeeper ran out of her room through the kitchen and out of the door, closing it behind her. The two men ran after her, shot her through the glass, ran to the bedroom, made a search until they found the money, and leaving the house heard and saw the housekeeper pounding and clawing at the front door of the tenant house and screaming to be admitted. Ignoring her, they entered the rear door of the house, discussed the screams with the women folks, and then went to bed. They said they got about two hundred dollars and each man accused the other of having kept it.

At the trial the farmer repudiated this confession, and when questioned about the "heavy burden" he had spoken of, said it was the fact that he had lied about not having any guns. An expert for the prosecution testified that under the microscope he had found nine abnormal defects in the flare of the muzzle of Stielow's gun, and found nine corresponding peculiar scratches on the four bullets taken from the bodies. The scratches were not visible to the naked eye, he said, and were first detected under the lens, and he gave it as his opinion that all the bullets were fired from Stielow's gun and could have been fired from no other.

On cross-examination it was brought out that the enlarged photograph of the bullets showed to the jury by the "expert" did not reproduce the nine marks; it was, for some unknown reason, a photograph of the opposite side of the bullet.

Asked why the uneven ridges at the very extremity of the barrel should mark the bullet, the "expert" replied: "The cylinder fitted so tightly against the rear of the barrel that there was no leakage of gas at the breech. The full force of the gas following the bullet out at the muzzle, the lead expands as it leaves the muzzle, fills in any depressions existing at the outer edge of the bore and receives scratches from the elevations existing between said depressions."

On the basis of the "expert" testimony that the bullets had been fired from Stielow's revolver and could have been fired from no other, the jury found Stielow guilty of murder in the first degree and sentenced him to die in the electric chair some time during the week of September 5, 1915. Green was told that Stielow had been sentenced to death and that if he would confess he might get off with twenty years. Accordingly he plead guilty and was sent to Auburn Penitentiary.

But Stielow did not go to the electric chair. His lawyer was convinced of his innocence and began a series of appeals, and a Humanitarian Cult of New York City began taking an interest in the case. Members of this Cult soon found some slight evidence that two tramps and horse traders who had been in the vicinity of the house might know something of the murders.

While this investigation was going on, the case had been reviewed by the Court of Appeals and a motion for a new trial was denied in February 1916. In June of that year a second application for a new trial, and in July a third, were denied, and in October a fourth appeal met the same fate. All the judges found that Stielow had been fairly tried and justly convicted.

In the meantime the Humanitarian Cult had been strengthening the evidence against the two horse peddlers and finally on December 4, 1916, the Governor, unsatisfied of Stielow's guilt, commuted his sentence to life imprisonment.

During this time the ignorant farmer had been adjudged guilty by a jury and by ten judges who had subsequently passed on his case in connection with the numerous appeals. Finally the Governor had one of the two suspected horse traders brought before him and his answers were so evasive and unsatisfactory that the Governor appointed a prominent Syracuse lawyer, Mr. George H. Bond, to conduct a special investigation into the case of the murder of Phelps and his housekeeper, Miss Wolcott. Mr. Bond drafted Mr. Waite from the Attorney General's office to aid him.

Under searching analysis, the confessions of Green and Stielow, once considered solid evidence, appeared in a new light. Such glaring inconsistencies were discovered as to make it almost self-evident that the men who made the confessions could not have had first hand knowledge of the crime.

After shooting down Phelps, as told in the confession, Stielow was supposed to have picked up the lamp and advanced from the kitchen through the dining room and a small hall, and was just about to enter the old man's room to search it, when Miss Wolcott ran out of her room, through the dining room toward the kitchen door. By the time they reached the kitchen she was outside and the door was closed behind her. They shot her through the glass door and heard a scream. If the confession is to be credited, the two men fired at the fleeing woman, and did not even bother to see whether or not she was hit, but let her run screaming into the night to arouse the neighborhood, while they returned to ransack the premises and make a careful search for the money.

Miss Wolcott, when she ran through the kitchen passed close to Stielow who was carrying a lighted lamp and wore no disguise. His mere bulk would have identified him, and it is incredible that she would have failed to recognize this man who had been working on the farm under her direct observation. Yet to credit the confession, we must believe that the housekeeper fled directly to the home of her slayer for sanctuary, crying out to him by name to open the door, knowing as she must have that he was not there but in the house from which she had just run.

At the least calculation, it would have taken an expert cracksman ten minutes to make the search of the bedroom as detailed in the confession. Yet when Stielow and Green emerged from the house after finding the money, Stielow is supposed to have heard Miss Wolcott crying, "Charlie, please let me in, I am dying," and beating on the door of the tenant house.

Miss Wolcott had been shot directly through the heart with a jagged and deformed bullet which had been battered out of shape by first passing through a pane of glass. Yet this woman of fifty is supposed to have run a hundred yards after she was shot, and at least ten minutes later to have been screaming loudly enough to be heard in the next house.

Apparently no one had even taken the trouble to measure the distance from the floor to the hole in the glass of the kitchen door, and check it against the statements of the defendants. The confessions stated that Miss Wolcott was outside, with the door closed behind her when she was shot.

Outside the door, which opened inward, there were several steps leading down to the ground. The threshold was less than two inches wide. No one could stand on the threshold while the door was closed.

The hole in the glass was exactly three feet eight and one-half inches from the floor, and showed plainly by its shape that the bullet had gone through on a line, and not on an angle. The course of the bullet through the body also indicated that the shot had been fired on a nearly horizontal line. Miss Wolcott was half an inch less than five feet tall. Once she was outside and the door closed, a bullet could not hit her below the shoulder. The height of the wound in her body was exactly that of the distance from the kitchen floor to the hole in the glass. The conclusion was irresistible that she was shot while the door was partly open and she was on the level of the kitchen floor, or at the moment of leaving it and turning to leap from the steps, and that whoever fired the shot was not pursuing her as Stielow's confession stated, but was standing over the body of Phelps behind the partly opened kitchen door.

Firing tests were made with Stielow's revolver in the presence of Captain Jones, the revolver expert of the New York Detective Bureau, Dr. Otto Schultz, Police Surgeon, Inspector Faurot, Bond, Waite, and others. Before firing, the revolver was handed to Captain Jones and his opinion asked as to how long a time had elapsed since it had been fired. "Certainly three or four years, apparently a longer time," Jones said after he had examined the heavy incrustations in the barrel, discolored with age. According to Stielow, the gun had not been used for seven years.

The first test was made by placing a sheet of paper over the gun and firing a cartridge of the same type as those found in a box in Stielow's possession. Instead of there being no leakage of gas at the breech end of the barrel, as the expert had testified, the paper was set on fire. Afterward bullets were fired into cotton and recovered and the test bullets were then taken to the Bausch & Lomb plant at Rochester for scientific examination by Dr. Max Poser, an expert in microscopic research.

Neither Dr. Poser nor anyone else could find a trace of the peculiar scratches which had doomed Stielow, either under high or low powered lens, but even more amazing was the fact that one of the lands on the murder bullet was abnormal, equalling the combined widths of two normal lands and one groove, while there were five lands and five grooves all of normal width on the test bullets from Stielow's gun.

The killing of Phelps and his housekeeper undoubtedly had been done with a defective gun in which the rifling tool had presumably been broken, or the rifler had failed to complete his operation and the error had escaped the inspector's notice. The distinction between the two sets of bullets was glaring, and there was no possible chance that the fatal bullet could have come from Stielow's gun.

The micrometer completed the evidence. When the bore diameter of the Stielow gun barrel and that of the murder bullets were compared, the bullets were found to be .0018 of an inch smaller. These were not opinions; they were facts.

Bond and Waite had no further doubt that Stielow was innocent, and the Governor accordingly pardoned him. The two horse traders were brought to trial and made a full confession, telling many facts which had not been known before but which were easily checked up and found to be true.

This case got Waite to thinking that if enough data on arms and ammunition could be collected, some method might be evolved whereby it would be possible to determine at least the make of arm, and perhaps even the particular individual gun figuring in a given case. He accordingly visited factories in this country and abroad and collected a mass of data on guns of all kinds.

One of the first things necessary was to know the principal dimensions, such as the bore and groove diameter, the number, and width of the lands and grooves, the pitch and direction of the rifling, etc. All this information was gathered for all current American arms; but it was necessary to have more than this. Very frequently it happened that the weapon involved might be either of foreign make or some old model which had long ago been discontinued. It, therefore, became necessary to collect data on not only the more common guns but on all the foreign guns, and, as far as possible, on all the old, obsolete models.

Collecting this information, especially on the older models, required years of work, for in many instances many factories had no records of their older models and in trying to find out about them, Mr. Waite consulted old, retired foremen who in many cases furnished information from their private notebooks and other unofficial records.

However, when all the data on American guns, even the obsolete models, had been located, the work had still only fairly well begun as the country was flooded with cheap foreign pistols just after the World War and in many cases the trade marks or names of these guns meant little or nothing because frequently these cheap revolvers or automatic pistols were turned out by the thousands by little jobbing shops and individual contractors, and almost any trade mark imaginable might be used. One exporter with a certain trade mark might buy from one jobber at one time and from another at another time. However, it was found that there were certain more or less general patterns in use even by these small jobbing shops, and Waite determined to do whatever was possible to collect a codification of the miscellaneous information along these lines. Accordingly he started out to collect data from foreign countries, and armed with authority from the State Department and accompanied by an army officer as interpreter, he patiently waded through all the large factories and through dozens of small factories and gun shops, collecting their trade marks, their rifling standards, their various models, and in short, every characteristic of every gun in the world so far as it was possible. The result was the assembling of what is undoubtedly the most complete set of data of this kind in the world.

When Waite started out to collect this information, his idea was that it would enable him, after examining a fired bullet, to state definitely what make of gun it came from. Unfortunately, even with all this information at hand, it is usually not possible to say positively that a bullet came from such a make of gun and could have come from no other make. In the large European centers for the manufacture of cheap firearms, such as Liège in Belgium and Eibar in Spain, there are dozens of small shops using the crudest of equipment, which turn out quantities of revolvers and automatic pistols on the contract system for large exporters. These guns are often made largely by hand, under sweat-shop conditions, where gauges and accurate "standards" of manufacture are conspicuous by their absence. Moreover these small shops often copy closely some popular American arm, such as a Colt or a Smith & Wesson, and frequently they copy the inside barrel dimensions as well as the mechanism and outside appearance. Hence a bullet that appears to have come from a Colt or a Smith & Wesson gun may just as well have come from a Spanish imitation of the gun in question.

It is a difficult job at best to collect data on all these small gun shops, but to make it worse, their products are subject to change at any time. Some of these little assembling shops do not even own a rifling machine, but buy their barrels in the shape of long tubes already bored and rifled, ready to be cut into convenient lengths and made into finished barrels without any more work being done on the inside. When one lot of this barrel stock runs out, they may make the next purchase from another maker, with the result that the barrel and groove dimensions, the twist, and even the direction of the rifling, may be entirely different. The cautious and well informed firearms investigator will therefore hardly be able to state that a particular bullet can have come from one particular make of gun and no other.

Nevertheless, the information referred to is extremely valuable, for by its use the expert can *narrow down his field of search* from dozens of makes to one or two at most, with always the added possibility of some unknown foreign mongrel gun in the background. If, for example, his .32 caliber bullet has 5 lands and grooves, he can at once positively eliminate all those makes having six grooves like the Colt, 7 grooves like the Remington, or 4 like the Dreyse, etc.

On his return to New York, Waite became associated with Lieut. Col. Calvin H. Goddard, Ordnance Reserve Officer and well known firearms expert; Philip O. Gravelle, famous expert microscopist and photographer; and John H. Fisher, an authority on precision measurements. These men established the so-called "Bureau of Forensic Ballistics" in New York City, and together brought the science of bullet identification to its present state of precision.

It is interesting to note that Mr. Gravelle, mentioned above, who is one of the most famous microscopists in the country, applied the already well known comparison microscope to the problem of bullet identification, and perfected the technique of using it for this purpose. Many people who have read one or more of the numerous articles on the scientific identification of firearms have gathered the impression that the comparison microscope is something that was invented especially for this bullet work. This is not so. The comparison microscope has been known for a long time, and is regularly employed for making very close comparisons of similar substances, such as, for example, ground pigments. The author, who has done microscopy and photomicrography of various kinds for over 20 years, used the comparison microscope long before it was heard of in connection with bullet identification. This instrument is described in detail in a succeeding chapter.

Waite died in November, 1926, but the Bureau was continued by Col. Goddard until June, 1930, when the records and instruments were taken by him to the Scientific Crime Detection Laboratory of the Northwestern University at Chicago. Later, Col. Goddard established Calvin H. Goddard Associates, of Chicago, consisting of Col. Goddard himself and a number of able assistants, and this organization of consulting firearms experts now carries on the work that Col. Goddard was so largely instrumental in reducing to the status of an exact science. Capt. Edward C. Crossman, of Los Angeles, famous writer and expert on firearms, was formerly a member of Col. Goddard's Consulting Staff, and now handles Identification work on the West Coast.

In addition there are quite a few other well qualified operatives in this field, and their number is increasing all the time, as the subject becomes better known and as the various law enforcement agencies and police departments install the necessary instruments and train some member of their personnel to handle this work. Prominent among the organizations having well equipped firearms identification laboratories and skilled personnel to use them are two belonging to branches of the Federal Government. These are the Bureau of Investigation, Department of Justice, and the Bureau of Standards, Department of Commerce. The Department of Justice, now so prominent in the war against crime, may well claim an important share in the credit for the development of the science of firearms identification, as Waite, whose efforts had so much to do with originating this science, was at one time a Department of Justice operative.

Because this science is very new it is still in the throes of vigorous growth. Important contributions to methods and technique are constantly being made by prominent practitioners such as Luke S. May, of Seattle, whose Magnascope may go a long way towards eliminating the comparison eyepiece; and Captain C. A. Peterson, of Miami, Florida, whose bullet camera has a moving film geared to the bullet stand in such a way that it takes a single picture in the form of a long strip showing all sides of the bullet at once. As time goes on, instruments and methods are bound to be much improved at the hands of such men.

FIREARMS IDENTIFICATION OF TODAY

We still have with us the expert witness on firearms, but in the past few years there has been a tremendous change in the character of the men posing before the courts as Firearms Experts, and in the degree of knowledge possessed by them. A few years ago, almost anyone with a good stage presence and unlimited gall could learn a few mysterious sounding terms relating to firearms, and then get up and hoodwink the average court and jury. Some of the proceedings indulged in by these self-styled "Experts" were the most arrant quackery. Remember, for instance, the case referred to in the early part of this chapter, where the expert cut off the jacket of the bullet, and looked at the lead underneath with a hand magnifier, and then swore that the bullet could have come from no other gun than the one belonging to the accused, in spite of the fact that the bullet had six grooves and the gun only five!

Such men were, of course, downright charlatans. In an entirely different class, though often equally ineffective, are the many target shots, rifle club secretaries, sporting goods clerks, locksmiths, people with military pretensions, workmen in arms factories, etc., who actually do know a great deal more about guns and how they work than does the average citizen, but who are likely to find themselves hopelessly out of their depth when they try anything like advanced bullet identification. Some of these very good and conscientious people, who have let themselves be persuaded to rush in where angels fear to tread, have made truly pitiful spectacles on the witness stand, and in many cases have seriously predjudiced the cause of Justice.

Of course, these people in many cases do know a lot about the different guns and their characteristics, and very often are in a position to be of great assistance in the preliminary investigation of a firearms case, if they will be careful to stick to what they really know, and will not be afraid to admit that they may not know everything about the subject. Usually they know what kinds of arms exist, what the cartridges for them are like, what rifling is, the direction of the twist, the number of lands and grooves, the peculiarities of the different guns, etc., and often they can in a few minutes clear up puzzling points and give hints that will put the investigating officers on the right track. Almost any such man could have cleared up the Stielow case at once, for if he had been shown the fatal bullet and the suspected gun, and had been asked if the bullet came from that gun or some other, he would have seen that the bullet had been fired in a gun that had one of the grooves missing.

For this sort of common-sense work we need first of all what is commonly known as a "gun-crank;" one who has an absorbing interest in firearms of all kinds, and who loves them enough to own and shoot guns and experiment with them, and who will pore over the catalogs of the various gun and ammunition companies, learn all the different models, study the ballistic tables, attend the big shooting competition, load his own ammunition, etc.

We have already seen, in the first part of this chapter, how in several cases men who were familiar with firearms were able to avert serious miscarriages of justice, and this without any recourse to laboratory methods, or to anything except common sense coupled with a fair knowledge of firearms. In none of these cases was advanced bullet identification necessary. It does not require a microscope to tell that the bullet cannot have come from the defendant's gun if the bullet has six grooves and the gun only five.

When we come to what in this book is called Advanced Firearms Identification, an entirely different type of training and experience is necessary. However, before describing what the advanced expert should know, let us say a word about just what is meant by Advanced Bullet and Cartridge Identification.

When a gun is made, the face of the breech, which supports the head of the cartridge against the pressure of the explosion, must be finished off smooth in some way. This is done by machining or by filing. In either case, fine marks are left in the surface of the metal, and though it looks smooth to the eye, an examination under the microscope will show that it actually is covered with fine ridges and furrows. When a cartridge is fired in the gun, the very heavy pressure of the gas inside the cartridge will force the head of the cartridge back against the face of the breech, and often will impress the imprint of these fine scratches into the brass of the cartridge head. But the primer is made of still softer metal, such as gilding metal or very soft brass, and moreover, the primer cup is relatively thin, and has the full force of the gas exerted on the inside. For this reason, the fine lines on the face of the breech are imprinted even more clearly on the primer than on the cartridge head. Moreover, the firing pin may be broken, or it may have an irregular shape, or it may have distinctive tool marks on it, and the firing pin leaves marks of these things on the primer. If the edge of the firing pin hole in the breech-block is eroded or irregular, it also will leave its distinctive impress. If a cartridge is suspected of having come from a certain gun, it may be compared under the microscope with one known to have come from that gun, and in many cases it can then be seen whether or not it did come from the gun in question.

When a gun barrel is made, it is first bored, then it is reamed to size. Both the boring and the reaming operations will produce fine scratches in the surface of the bore. These marks run at right angles to the longitudinal axis of the bore.

Then later, when the gun is rifled, spiral grooves are put into the bore by cutters in a bar which is drawn through the barrel from end to end, and turned slightly at the same time. These cutters will also leave scratches in the metal, and these scratches will be parallel to the direction of the rifling grooves. Thus the tops of the lands will in general have microscopic ridges and depressions running across them, while bottoms of the grooves will be covered with irregularities consisting of small raised spots or rough places, and little gouges or tears in the surface, in addition to which there may be long scratches running parallel to the direction of the rifling. In every gun these surface irregularities are different. They are not exactly the same even in two different parts of the same barrel, for the operation of machining steel is in reality a tearing operation, in which the edge of the cutting tool is forced under the surface layer of metal, which is then pushed along and lifted or wedged up at the same time, so that the part to be removed is really torn from the surface. This tearing operation leaves a constantly changing pattern of irregularities and rough spots in the surface.

When a gun is fired, the bullet has its surface lined and scored by the minute irregularities existing on the surfaces over which it passes, and if a bullet is suspected of having come from a given barrel, this suspicion can often be confirmed or disproved by a microscopic comparison of the bullet with one known to have been fired from the gun in question.

This microscopic examination of fired cartridges and bullets, together with the recording and presentation by means of photography of what is revealed by the microscope, is called Advanced Firearms Identification. When it comes to work of this kind, it is relatively unimportant for the operator to be a gun-crank, though a knowledge of firearms and their construction and use, and a familiarity with the different kinds likely to be encountered is indispensable. However, if the operator is to become really good, he should know far, far more about photography than the average gun-crank will ever know; and it is essential that he should have had training and experience in laboratory work, and especially in the use of the microscope. He should have worked with all the different kinds of microscopes which are commonly in use, such as the ordinary laboratory instrument which is used for high power work by transmitted light; the Micro-metallograph, using the verical illuminator for the examination of opaque objects; and the wide-field double objective binocular, or Greenough type microscope, so useful in low power observations. Such an experience will give him an interest in the microscope and an understanding of its use and theory that will enable him to obtain results in difficult cases that would simply be dropped by many of the people using Comparison Microscopes today.

To the large city police department, or identification bureau I would say, get a young man with scientific training, and make him your laboratorian. He can eventually learn to do not only bullet and cartridge comparison, but also blood stain tests, powder work, and many other kinds of microscopic and laboratory identification in general, and you will be on the road to building up a real crime detection laboratory where the resources of modern science will be used to the fullest extent to outwit the criminal.

The work of Goddard and his associates has advanced the science of firearms identification to the point where such knowledge and equipment is available that the court can always assure itself of the services of an expert who is in a position to give the court and jury FACTS rather than OPINIONS. The day of the self-styled "Expert," who trades on the layman's lack of technical knowledge of firearms in the manner that has been described in the first part of this chapter, is past. One of the main objects of the author in preparing this book was to make available in easily understandable form such information as would enable the average attorney to check up on the methods and evidence of those posing as Firearms Experts, and see whether or not they are telling the truth; for if they are, there can no longer be the spectacle of two "experts" testifying in the same trial, one on each side of the case, and giving contradictory evidence. The qualified expert will be able to say in every instance whether the crime bullet *could* or *could not* have come from the suspected gun, and will be able to give plain reasons, free from all mystery, and readily understandable by all. Every other honest, qualified expert would testify exactly the same thing.

This testimony would be based on a comparison of the rifling marks and diameter of the bullet with the corresponding dimensions of test bullets fired from the gun in question. If the diameter of the bullet corresponds to the diameter of the barrel, and the width and number of the lands and grooves, and the pitch of the rifling on the bullet correspond to those of test bullets fired from the barrel, then the bullet *may* have come from that gun; and it *may just as well* have come from *another gun of the same kind.* But if there is lack of correspondence in any of these things, the bullet *cannot* have come from that gun, and there can be no difference of opinion between experts on these points. They are *facts,* and are not open to argument.

Carrying the matter further, if the dimensions all correspond, a microscopic examination *may* tell whether or not the bullet came from that particular gun, and it *may fail* to give this information. However, in the majority of the cases where a bullet actually was fired from a given gun, the microscope will plainly show that it was fired from that gun, and can have been fired from no other; and likewise, when the bullet did not come from the suspected gun, the microscope will usually come to the rescue and show plainly that the bullet *did not come from that gun.*

In a certain percentage of the cases, also, the microscope will show the investigator that he cannot hope to answer the question positively; the markings on the bullet may be too faint, or for some other reason, the investigator may find himself unable to find either a sufficient correspondence to prove that the bullet did come from the gun, or a sufficient dissimilarity to prove that it did not. The microscope may fail for lack of sufficient material to work on, but in the hands of a qualified operator it will not make a mistake. Either the bullet corresponds, or it does not correspond, or there is not enough evidence to tell whether it does or not. With capable, qualified experts on the job, the question of whether or not a bullet can be proved to have come from a suspected gun is always a question of fact, not of opinion.

Moreover, the facts revealed by the microscope can be put into photographic form for future reference, and will thus be available for examination at any time should the case come up for review, or should any other circumstance make such an examination of the evidence desirable. And these photographs will show the same thing for any expert who makes them. They cannot be made to testify for the side which can pay the largest fees. Of course, however, there is a difference in the ability of the various experts to use the microscope and camera, so that in the hands of a very skilled operator they may show the correspondence or lack of correspondence very clearly, while in the hands of a poor or mediocre operator, they may show the same thing faintly, or may even fail to show anything at all.

Qualifying the Expert

In view of the fact that the evidence given in a criminal case by a firearms expert may be a matter of life or death for the accused, it would seem that the most stringent rules should be adopted as to just who is to be allowed to appear in court and give expert testimony in firearms identification cases. No lawyer can practice without first passing the regular examination and being formally admitted to the bar; and it appears only reasonable that there should be a standardized examination for qualification as Expert Witness on Firearms, and that all candidates should be required to qualify and be registered before being allowed to appear in court, instead having their qualifications determined separately by the court in each case, as is done at present. Frequently in the past, a reputation gained chiefly by writing about some phase of firearms activity far removed from the actual work of bullet identification has been mistaken for a qualification for court work in firearms. The trouble is that many courts do not possess the necessary technical knowledge to determine whether or not the self-styled expert really has the proper technical qualifications. It is this fact that is responsible for some of the deplorable miscarriages of justice in the past, where utterly unqualified, or even willfully insincere persons have been allowed to testify as expert witnesses, and swear away the life or liberty of innocent persons in the most outrageous manner, as has been described in the several cases referred to earlier in this chapter.

"Ballistics" and Firearms Identification

In some unknown way the word "ballistics" has in the past several years become associated in the public mind with the science of Firearms Identification, which has received a great deal of publicity under various names, such as "Forensic Ballistics," "Legal Ballistics," or just plain "Ballistics." On the occasion of a recent celebrated murder trial involving a controversy over the merits of Bullet Identification, one of the large daily newspapers called me on the telephone to ask what I thought of "Ballistics." Of course I knew that they really wanted my opinion of the science of Bullet Identification, not of *Ballistics*, which is "the science of the *Motion of Projectiles.*" (Webster's New International Dictionary).

I realize fully that usage makes language, and that the recent rather extensive mis-use of the word Ballistics in this way may be a valid excuse for continuing the practice; but still it seems to me that the use of the word to describe the Science of Firearms Identification is somewhat undesirable in any case, as being loose English, and that it is even more undesirable for the Identification Expert to use it this way, because as an exponent of an exact science, he would do well to cultivate exactness in language as well.

Whether or not he uses the term himself, it is advisable for the worker in firearms identification to know the exact definition of the word "forensic." According to Webster's new International Dictionary it means "belonging to courts of judicature or to public discussion and debate; used in legal proceedings, or in public discussions; argumentative; rhetorical; as forensic eloquence or disputes."

CHAPTER 2

ELEMENTARY PRINCIPLES OF FIREARMS

THE man who expects to appear in court as an expert on firearms should know as much as possible about them and their ammunition, and about everything connected with their use and effects, for he must realize that very likely an attempt will be made to discredit the extent of his knowledge, and if he is not the possessor of a lot of collateral information regarding matters of this kind, he may find himself the victim of his own lack of a broader knowledge of his subject.

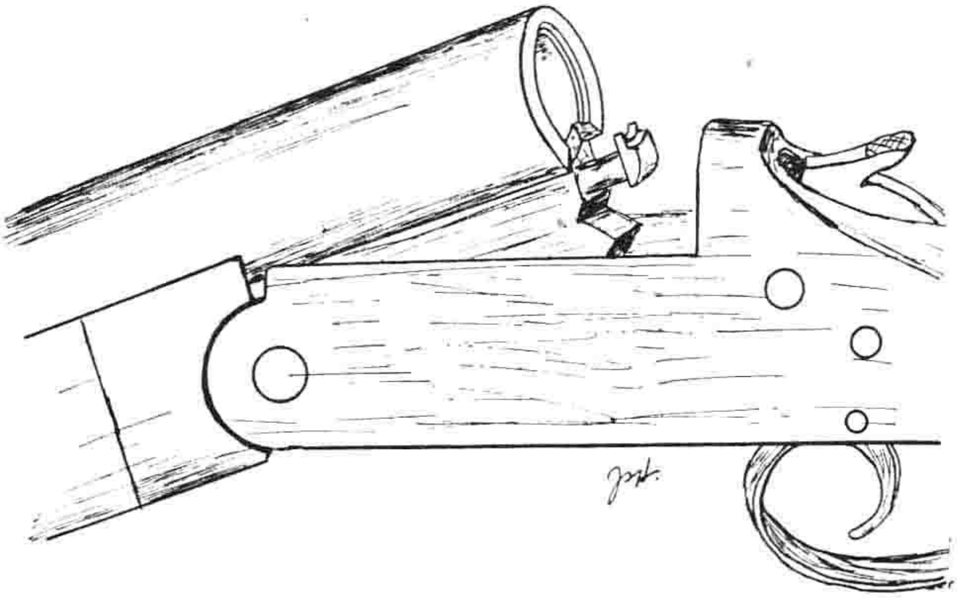
Of course, there are some kinds of firearms that are most often involved in crimes of violence, and others that are more rarely encountered in court work; but any kind or type whatever of firearm may figure in a court case, and the identification expert should at least know what kinds exist, some of their more important characteristics, and he should take great care to become acquainted with the technical terms and nomenclature used in the firearms world.

The arms most often involved in shooting cases are the automatic pistol, the revolver, and the sub-machine gun, followed by the old familiar shotgun, which is found behind the kitchen door in every farmhouse in the land, and therefore often figures in crimes of violence; less often, the rifle, and still more rarely, the single-shot target pistol may be the weapon used.

Single-Shot, Double and Repeating Guns

As to their cartridge capacity, guns may be divided into two main classes; those which have to be reloaded for each shot, or *single shot* arms, which may be shotguns, rifles, or target pistols; and those which will fire several shots with one loading, or *repeating* arms. The familiar single barrel shotgun is the most common example of the first mentioned class, while the revolver, the automatic pistol, the machine gun, the repeating rifle, and the pump action shotgun are examples of the second class. Then there is the commonly used double barreled gun.

To use a single-shot rifle, pistol, or shotgun, the breech is opened by hand, the cartridge or shot shell is inserted into the chamber, also by hand, and then the breech is closed. Sometimes, as in hammerless guns, the opening of the breech cocks the hammer or firing mechanism; otherwise, it must be cocked by hand before firing. The hammerless guns always have a *safety* of some kind, which is a latch which may be placed in the "Safe" position to prevent the trigger from discharging the gun when pulled, or may be placed in the "Ready" position to allow the gun to be fired.



The extractor on a single barrel shotgun. When the gun is opened, a cam or leverage connection inside pushes the extractor out to the position shown. When the gun is closed, the extractor recedes until it forms a portion of the bottom wall of the chamber. When it is operated by a spring action, so that it throws the shell clear of the gun, it is called an ejector. When the gun is closed, the ejector or extractor helps to support a small portion of the cartridge wall, and an impression of such place occupied will generally be seen on fired shells.

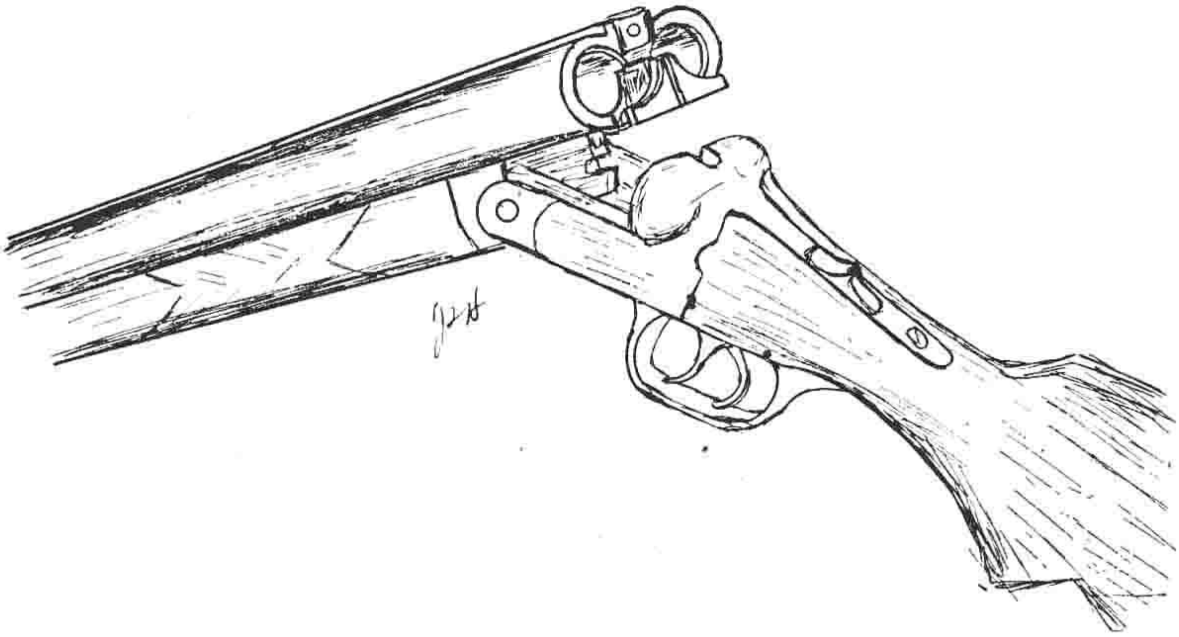
After firing, the breech is opened by hand, and this action operates the extractor, or ejector, which is a movable segment of the breech end of the barrel or chamber against which the rim of the cartridge rests, and which is arranged to be pushed to the rear by the action of opening the breech. When the extractor moves to the rear, it pushes the empty cartridge case far enough out of the chamber for it to be grasped by the fingers and removed. Some single shot guns have an extractor which is actuated by a strong spring, so that when the breech of the gun is opening, the spring is suddenly released, and the empty shell or cartridge is kicked clear out of the barrel without its having to be touched by the fingers at all. In this case, the extractor *ejects* the empty case from the gun, and is called an *ejector,* or an *automatic ejector.*

Just one step removed from the single shot arms are the well known double barrel shot guns, and the less common double barrel rifles, which have two barrels, each with its own firing mechanism and ejector, arranged side by side or one barrel over the other, on the same stock. Double barreled guns are just like two single guns mounted on the same stock. As there are two separate barrels, the user can fire twice without reloading. Double barreled shot guns are extremely common, but double rifles are not often seen in America, as they are made principally for the heavy English big game cartridges, and are used mostly for hunting in Africa or in India.

Sometimes a three barreled gun will be seen, which at first glance looks just like a double barreled shot gun; but on more careful examination it will be seen to have a third barrel, generally rifled, in the center just under the two upper barrels. It is well to bear in mind that guns of this type exist, for in any crime involving a rifled bullet, such a gun seen on the suspected premises might very well be passed by as being simply a double barreled shot gun. Occasionally a four barreled gun will be seen, which is made just like the three barreled gun above described, except that it has an additional rifled barrel placed just above the two shot barrels.

The ejector on a cheap, single barrel shot gun always throws out the shell when the gun is opened, regardless of whether or not the gun has been fired. It will throw out the loaded shell just as cheerfully as it will the empties, but not quite so far; however it always throws them too far, and may send them three feet or more if you do not cup your hand over the open breech and stop the loaded shell from coming out of the chamber. On the other hand, the ejector on a high grade double gun will not throw out the shell unless it has been fired. If only one barrel is fired, and then the gun is opened, the gun will throw out only the empty shell. The other one will be pushed back a short distance but will not be ejected.

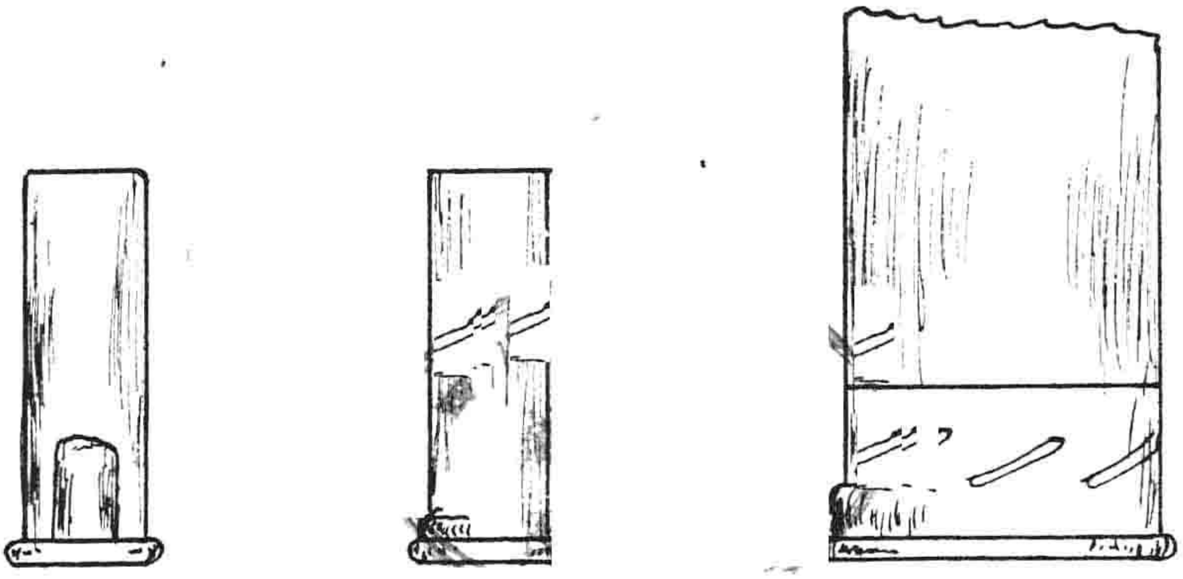
Thus the "ejector" on any double gun is both an extractor and an ejector. The closing of the action cocks the ejector mechanism, (which is all located in the forearm of the gun) and the falling of the hammer or firing pin trips the ejector and makes it ready for action. When the gun is opened, the ejectors snap just like the hammers do, and kick the empties well clear of the gun. But in case you do not fire the gun, but open it to change shells or unload, the action works like any extractor, and merely draws back both shells about one quarter of an inch, so that they can be taken hold of by the fingers and removed from the chamber. If only one barrel is fired, and then the gun is opened, only that one shell is ejected, and the other is merely pushed back slightly. Good ejectors are quite "snappy" in action and some of them will throw the fired shell a good ten feet to the rear. They are the biggest improvement one can have on a double gun.



Showing the ejectors on a double barrel, hammerless shotgun. These ejectors are operated, by a pair of lock mechanisms, located in the forearm, which are tripped and operated only when the gun is fired. When the gun is closed they drop in flush with the rear face of the barrels and form a portion of the bottom wall of the chambers. A visual indication as to whether or not a double gun is fitted with ejectors can be told by the appearance of this movable barrel segment; if it works in one solid part for both barrels, the gun merely extracts the shells; but if there be a division in the center of the segment (as shown above), permitting each half to work independently of the other, then the gun has ejectors.

The Harrington & Richardson U.S.R.A. model single shot target pistols have ejectors just like those on single barrel shot guns, and in these arms the ejector forms part of the bottom surface of the cartridge chamber. In the earlier models of this gun the part of the chamber formed by the upper surface of the ejector is about one-tenth of an inch wide and two-tenths of an inch long, and every cartridge fired in one of these guns will show a slightly raised rectangular mark just forward of the rim on the side opposite to the firing pin mark. The later guns of this same model have an ejector of different shape which leaves a crescent shaped mark, instead of a rectangular one, on the side wall of the empty cartridge case. This mark is shaped something like the white crescent at the base of the finger nail. As no other .22 caliber gun has just this shape of ejector imprint, the cartridge which bears this type of print is thereby definitely shown to have come from a Harrington & Richardson single shot pistol.

In revolvers there is an extractor which is a somewhat star shape piece mounted in the center of the cylinder so that its edges form a part of each chamber, and the rims of the cartridges in the chambers rest on top of these edges. With rim fire cartridges the metal of the cartridge wall is thin, and is made of soft copper, so that these rim fire cartridges usually show a distinct imprint of the part of the chamber that is cut away to allow the ejector to lie under the rim of the cartridge. With center fire cartridges, on the other hand, the walls of the cartridge near the base are thick, and are made of hard brass so that marks like those described are not seen except under unusual conditions, such as the occurrence of excess pressure.



"Extractor Swells" on fired cartridges. Left, rim-fire cartridge fired in Harrington & Richardson Single Shot Pistol, U. S. R. A. Model, with bulge on bottom of case where it has been forced into that portion of the chamber which has been cut away for the ejector. Middle, rim-fire cartridge fired in a revolver, showing a portion of the case next to the head swelled out to fill the space where the cylinder has been cut away for the extractor. The same kind of marking is often seen in center fire cartridges, especially where the extractor is poorly fitted. Right, Shotgun shell showing bulge in the base near the head where the metal has been expanded into the part of the barrel cut away for the ejector. This appearance is common in fired shotgun shells where a double gun has been used, but will not be seen where the weapon is an automatic shotgun or a pump gun.

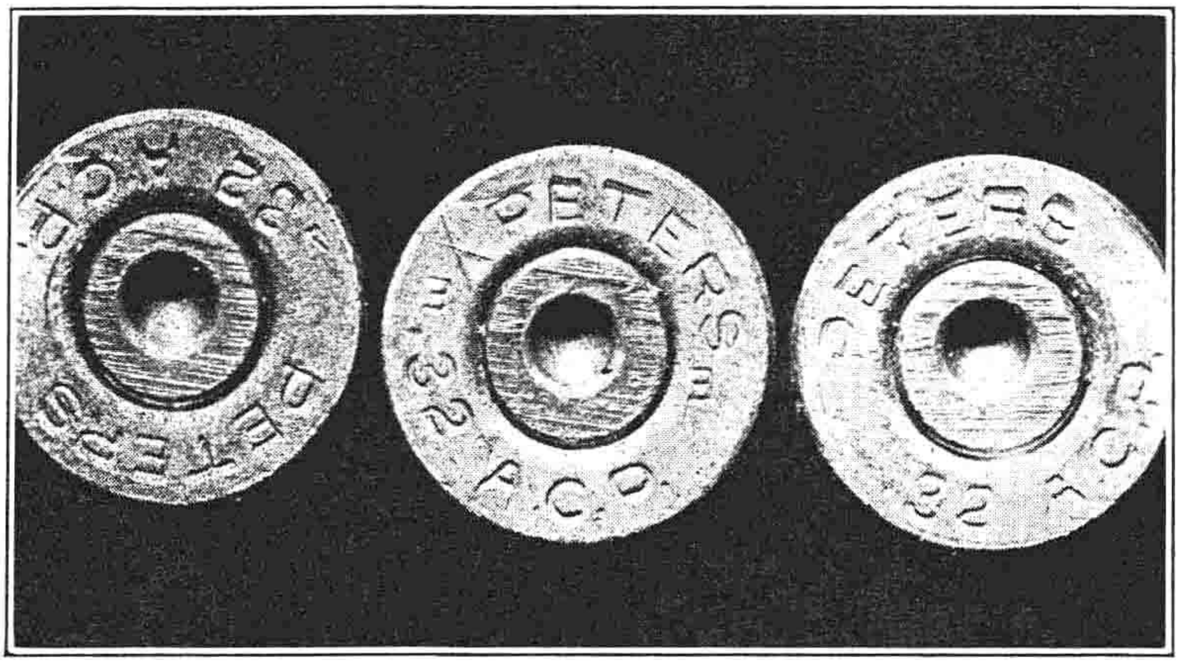
Many shot guns may leave extractor or ejector imprints of the same nature as those just described. These imprints, when they do occur, are on the side of the brass part of the shell just forward of the rim. Whether or not such a mark will be left, depends considerably on the fit of the extractor, and particularly on the amount of reinforcement placed in the base of the shell. In the older types of shot gun shells, especially those used with cheap black powder loads, there is not much of a "base wad" inside the head of the case; but with modern shells intended for the latest condensed types of powder, there is a considerable amount of reinforcement placed in the base of the shell, and this prevents it from swelling to any great degree.

With a high grade double barreled gun, the chambering is apt to be mighty good, and the extractors will fit so closely as to form a continuous surface with the chamber walls. The entire shell will be closed in tightly and completely and there will be much less chance for ejector marks to occur than is the case with cheap guns. However I have often noticed that in the case of a good grade double gun, where the owner carries a bit of oil in the action, (as he should), there is generally a sort of outline mark either in oil or in dirt where the extractor cracks bear. This is perhaps due to the sudden expansion of the shell brass plus the forcing out of oil by the shock of discharge. These marks will often remain on shells lying on the ground for a month or more and will be very apparent under a magnifying glass, but can easily be wiped off by hand. Once these marks are observed however, it is usually easy to see the extractor bulge of the shell underneath.

With the average cheap, double "extractor" gun it is sometimes possible to look at the swollen extractor bulges and tell whether the shell was fired from the right or the left barrel. The firing pin imprints, if they are on a downward slant, will enable one to turn the shell into the same position that it occupied in the gun and then the bulges will be located so that they will indicate the position of the extractor. This is particularly easy with the old hammer guns in which the firing pin used to run downward at a decided slant, and which made their imprint in the primer both inward and downward. But it is more difficult with modern, hammerless guns, many of which make a straight inward depression in the primer, as the firing pin works almost horizontally, or on a level with the bore.

The repeating and automatic shot guns have both an extractor and ejector, as do the repeating rifle and the automatic pistol. Invariably in both these types of shot gun the manufacturer is rather generous with his chamber tolerances; the chamber is larger than it is in the case of the double gun, and has somewhat of a cone to it to facilitate the feeding of the new shell, which comes in on a slant from the magazine below the barrel. This coning of the chamber results in increasing the thrust against the bolt head when the gun is fired, and it has been my experience that shells fired from any type of a repeating shot gun, including automatics, show the distinct characteristics of this type of arm.

Invariably such a shell will be expanded more than one fired from a good double gun and there may be a decided cone to the brass just forward of the rim; for when the bolt head "sets back" from the base pressure it may allow the base to slip back out of the chamber a trifle. Some of these repeating actions, especially after years of use, are very loose and allow quite a considerable "set back." This set back often results in very decided marks on the primer and also on such portions of the shell base as do not contain any lettering or stamping. In some cases the primers will take an excellent impression of the fine scratches and file marks around the firing pin hole and these form the most decisive indication available regarding the particular individual gun which fired the shell.



This photograph by Capt. Crossman shows how primers can sometimes be identified by the markings left on them by the irregularities in the metal of the breech. Center is the fatal cartridge, and the ones on the left and right are test cartridges fired from a suspected gun. Note particularly the queer converging lines at the left side of the firing pin impression in the primer.

It is well for the student of identification to bear constantly in mind the difference in significance between such individual marking as the extractor imprints described above. Extractor imprints and other such marks form a very valuable indication as to the type of gun used but they would hardly prove that the suspected cartridge case surely came from any one individual gun, as it might equally well have come from any other gun of the same make and design. These marks do, however, form a valuable means of clearly eliminating other makes of guns, for the size and shape of the marks will show very positively what guns *could not* have fired the cartridge. On the other hand, the impression received by the primer of the file marks on the breech face are a sort of "finger print" or signature of the individual gun in question, as other guns of the same make will never have exactly the same file marks on the breech face.

Repeating arms may be divided into hand operated guns and automatics. Under the heading of hand operated repeaters, we have pump, or trombone action guns, lever actions, and the military style, or bolt action repeaters, as well as the ordinary revolver.

The most familiar repeating shotguns are of the sliding forearm type, known as pump guns, or sometimes as trombone action guns. The wooden part of the gun, under the barrel, known technically as the "forearm," is grasped by the left hand in using the gun, and in the pump gun, this is made to slide backwards and forwards, and is connected by a rod or bar to the breech mechanism. Under the barrel there is a tubular magazine containing several extra cartridges. When the gun has been fired, the forearm is drawn backwards, and through its connecting rod, this operation opens the breech, and extracts and ejects the empty shell or cartridge case, and also allows a fresh cartridge from the magazine to come into position to be inserted into the chamber. Pushing the forearm forward then causes the breech block to push the fresh cartridge into the chamber, after which it closes and locks the breech block, and leaves the hammer or firing mechanism cocked. This operation, which can be performed in a fraction of a second, makes the gun ready for another shot.

The pump, or trombone, action described above, is extremely popular, not only for shotguns, but especially for .22 caliber rifles, and to a smaller extent, for high powered hunting rifles also.

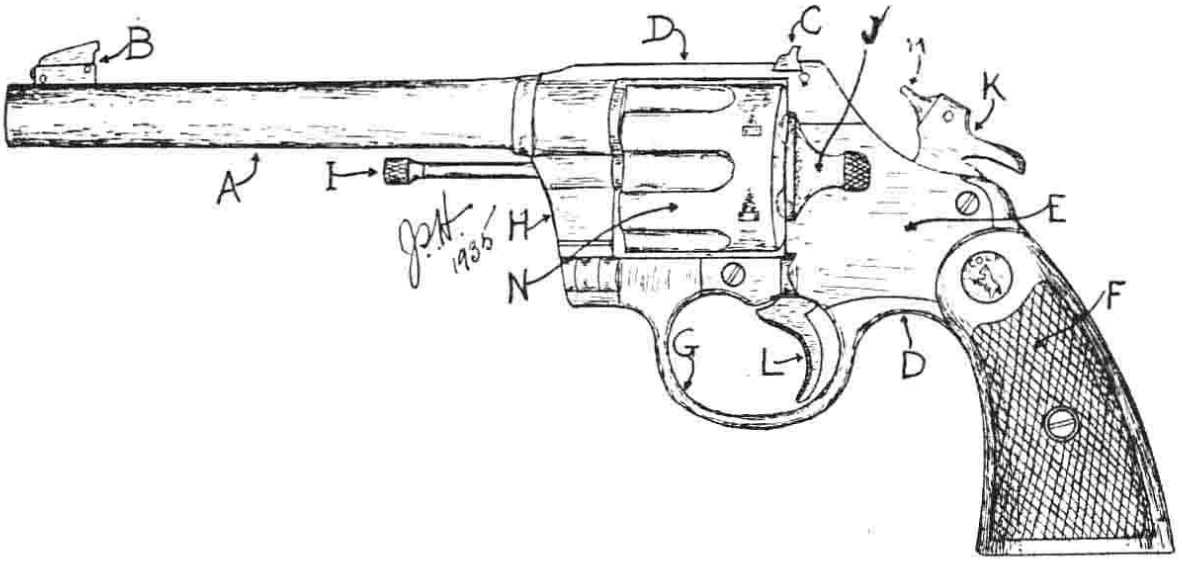
The lever action repeater has either a tubular magazine under the barrel, as described above, or a so-called "box magazine" just above or ahead of the trigger guard. The trigger guard is hinged at the front end, and has an extension at the back to form a finger lever, while there is also an extension on the front end, which is connected with the breech mechanism. After firing, the finger lever is moved downward and forward, so as to cause the trigger guard to pivot on its hinge, and its forward extension to move back. This motion unlocks the breech, cocks the firing mechanism, extracts and ejects the fired shell, and allows a fresh shell to come into position for insertion into the chamber. The reverse motion of the finger lever closes and locks the breech, at the same time pushing in the fresh cartridge.

The bolt action gun usually has a box magazine under the bolt, but some bolt guns have a tubular magazine under the barrel. The breech block is shaped like the ordinary door bolt, with a handle sticking out at one side. When the bolt is forward, and the handle is turned down, the bolt is locked to the breech of the barrel. When the handle is turned up, the bolt is unlocked. After firing, the bolt handle is turned up, unlocking the bolt, and then is drawn to the rear, extracting the fired cartridge, and finally, bringing it against the ejector, which throws it out of the gun.

The bolt action breech closure is occasionally used on single shot rifles, and once in a while it is seen on a single-shot shotgun. The action is the same as that described above, except that a fresh cartridge must be inserted by hand when it is desired to reload.

One way in which the repeater differs from the single shot arm which is important to the identification student is in the matter of extraction and ejection. We have seen above that in the shotgun, for example, there is a piece of mechanism which may either simply push the empty case partly out of the chamber when the breech is opened, or may automatically eject it clear of the gun, by spring action. Thus, in these guns, the extractor and the ejector are one and the same. Usually when it is arranged with a spring, to kick the empty clear out, it is called an *ejector;* otherwise it is called an *extractor.*

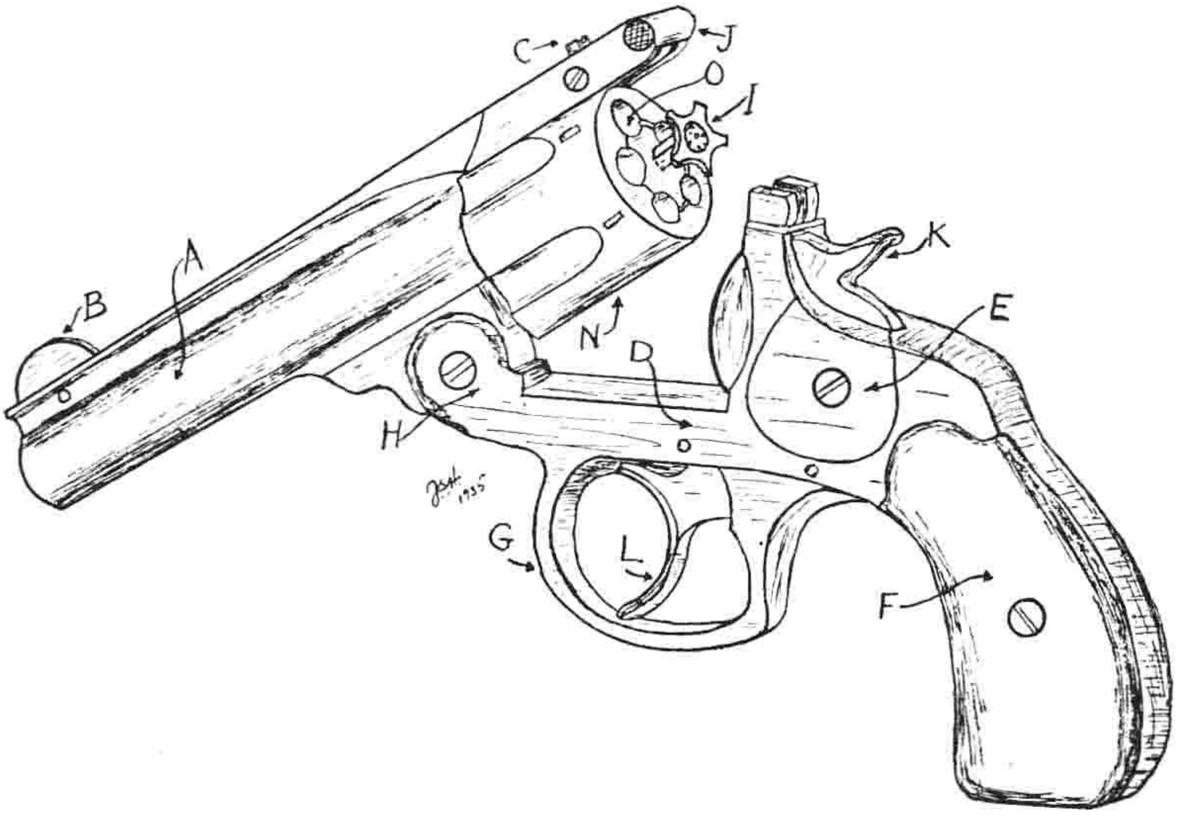
In practically all repeating guns, there are two separate devices; one, the extractor, is a hook which slips over the rim of the cartridge, and moves back with the breech block when it is opened, thus drawing the empty case out of the chamber, or *extracting* it. This hook is the *extractor.* Then when the breech-block nears the end of its rearward travel, the rim of the cartridge case strikes against a stationary piece of metal situated generally on the opposite side from the extractor. The extractor hook acts as a fulcrum, and the rim of the cartridge pivots around the extractor, and the cartridge is thrown clear of the gun, or ejected. The stationary piece of metal that the head of the cartridge strikes against to get thrown out of the gun in this way is called the *ejector.* Sometimes the firing pin is made to act as the ejector by being stopped in its rearward motion before the breech block stops. Thus the firing pin in effect thrusts forward on the primer, and causes the empty case to pivot around the extractor hook as before, and fly out of the gun. In other designs, the ejector is a spring plunger set into the face of the breech block opposite the position of the extractor. As soon as the forward end of the empty case clears the chamber, the compressed spring drives the ejector forward, flipping the empty out after pivoting it around the extractor as before. Some actions utilize the top cartridge from the magazine to expel the fired case.



An example of a Solid Frame, Swing-out Cylinder, Side Ejector Revolver such as is ordinarily used by the police, the military, and by target shooters. Its principal parts are: A—barrel, B—front sight, C—rear sight, D—frame, E—side plate, F—grip, butt or handle, G—trigger guard, H—crane, I—ejector rod, J—cylinder latch, K—hammer, L—trigger, M—hammer nose, or firing pin, and N—cylinder (of six chambers which are not visible).

The extractor is likely to make a mark on the forward face of the rim of the cartridge while it is withdrawing the empty, and more especially while the empty is being pivoted around it in ejection. Moreover, the bolt is usually drawn smartly to the rear, and the rim of the case comes against the ejector with considerable force. Thus the mark of the ejector is often plainly visible on the head of the case. These two things, the scratch or marred place left by the extractor hook, and the mark left by the ejector, are valuable aids in determining what type of gun was used to fire a shell that has been found, and they are still more often useful in showing what kind of gun was *not* used.

A very special kind of repeating firearm is the well known revolver. It has one barrel, behind which is a cylinder containing several chambers, usually five or six, but in some .22 caliber guns as many as eight, (Iver Johnson) or nine, (H. & R.). Each time the hammer is cocked, the cylinder is automatically revolved, bringing a new chamber in line with the barrel, so that the user can shoot five, six, or more times without reloading. Modern revolvers are divided into two general types, the "solid-frame" or "side ejection" or "swing-out" design such as the Colt make of weapon and some models of Smith & Wesson where the cylinder swings out to the left of the solid framed action; then there is the older "break frame" or "hinged action" type, where the top strap is unlatched from the breech and the barrel swung downward to open the gun. To extract the empties, the cylinder is swung out to one side with the former type, or the barrel and cylinder are tipped up, in the hinged frame models, and the empty cartridges are pushed out by a star-shaped extractor which fits around a section of each cartridge and is mounted on a central stem in the middle of the cylinder. In some of the older models, such as the Colt Single Action Army, the cylinder can neither be tipped up nor swung out, and there is no extractor; instead, the cartridges are put into the cylinder one by one through a loading gate at one side of the frame, and the empties are pushed out



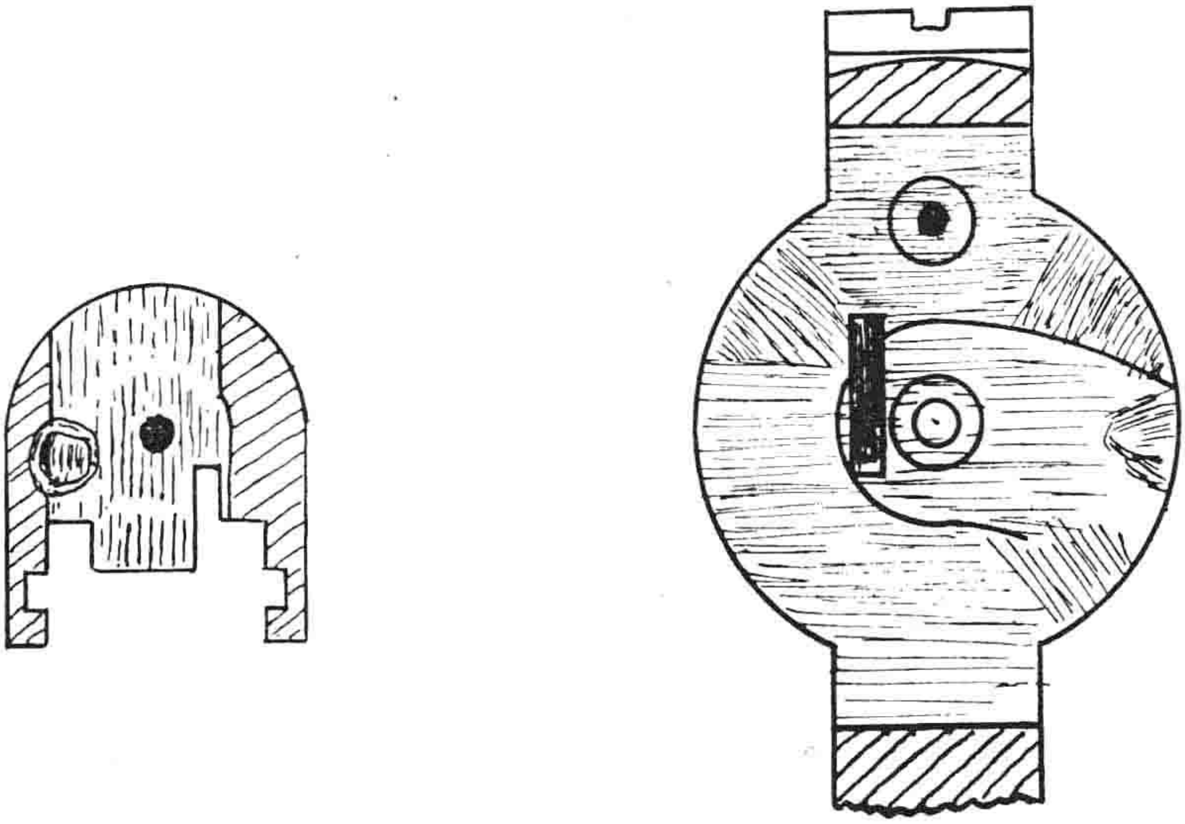
Example of a "Break Frame," "Hinged Frame," "Top Break" or "Tip Up" model of Revolver which figures frequently in court cases. This model is used mainly as a pocket or self defense gun. Its principal parts are: A—barrel, B—front sight, C—rear sight, D—frame, E—side plate, F—grip, butt or handle, G—trigger guard, H—hinge, I—ejector, J—latch or barrel catch, K—hammer, L—trigger, M—(hammer nose or firing pin is not visible), N—cylinder, and O—chambers.

one by one, through the same gate, by means of a ramrod attached to the under side of the barrel.

Because of this distinctive mode of extracting, the revolver does not give the identification expert any distinctive extractor or ejector marks, except occasionally a swelled portion extending part way around just forward of the head of the shell, similar to the extractor mark described above, under the single shot heading. This is caused in cheap or poorly fitted guns by having the extractor fail to support the cartridge at the rear end, where the chamber of the gun is cut away to allow the extractor to lie against the cartridge. Right at this point, just forward of the rim, the center-fire cartridge is rather thick, and there is usually no mark left even if the extractor does not fit perfectly. However, if the cartridge case is thin or the pressure is high, such a mark may be left.

Very frequently, the fired cases from a revolver may show scratches on the head, which are portions of circles, of the same radius as the distance of the point in question from the center pivot of the cylinder. This is because when the revolver is fired, the head of the cartridge is set back violently against the face of the breech by the pressure inside; and when the hammer is again cocked, the cylinder is revolved, dragging the head of the cartridge around in a circle across the face of the breech. If there are any little irregularities of the metal projecting above the surface, they will leave little scratches. Sometimes, a portion of the soft metal of the primer will flow or extrude back into the firing pin hole, and then when the cylinder is turned, this part of the primer will be sheared off, or dragged along the surface, and the marks will be circular in direction. The same thing may happen with other arms, but the marks will fail to exhibit a circular tendency.

The face of the breech, or the part of the frame just back of the cylinder, which supports the heads of the cartridges against the force of the explosion, is usually finished smooth by filing. In most solid frame revolvers these marks run crosswise of the frame, for the simple reason that the top strap of the frame prevents the workman from filing up and down. On break frame revolvers the marks may run across the face of the breech also, though they usually seem to run up and down. On automatic pistols, where there is an ejection opening at the top, such as the Colt .45 Automatic, the marks are likely to run up and down, for the filing is done through the ejection opening and the open space opposite. On guns with separate breech blocks, like the Thompson submachine gun, and on many automatic pistols, the breech face is usually finished by the use of a circular mill, and the surface will be covered with fine concentric circles, with the firing pin hole as a center. When a cartridge is fired, the pressure of the powder gas forces the cartridge head violently back against this surface. The primer is made of soft brass or copper, and easily takes the impression of all the tiny irregularities in this surface. The head of the case itself is made as hard as brass can be gotten, so that it will not expand under the pressure inside, and thus it does not take impressions of the surface as readily as does the primer; but often very important impressions of the breech surface may be found on the head of the cartridge case as well as on the primer. Fired cases differ greatly in the number and distinctness of the markings that may be received from the breech face, but usually there are quite a few distinctive markings of this kind visible under the microscope.

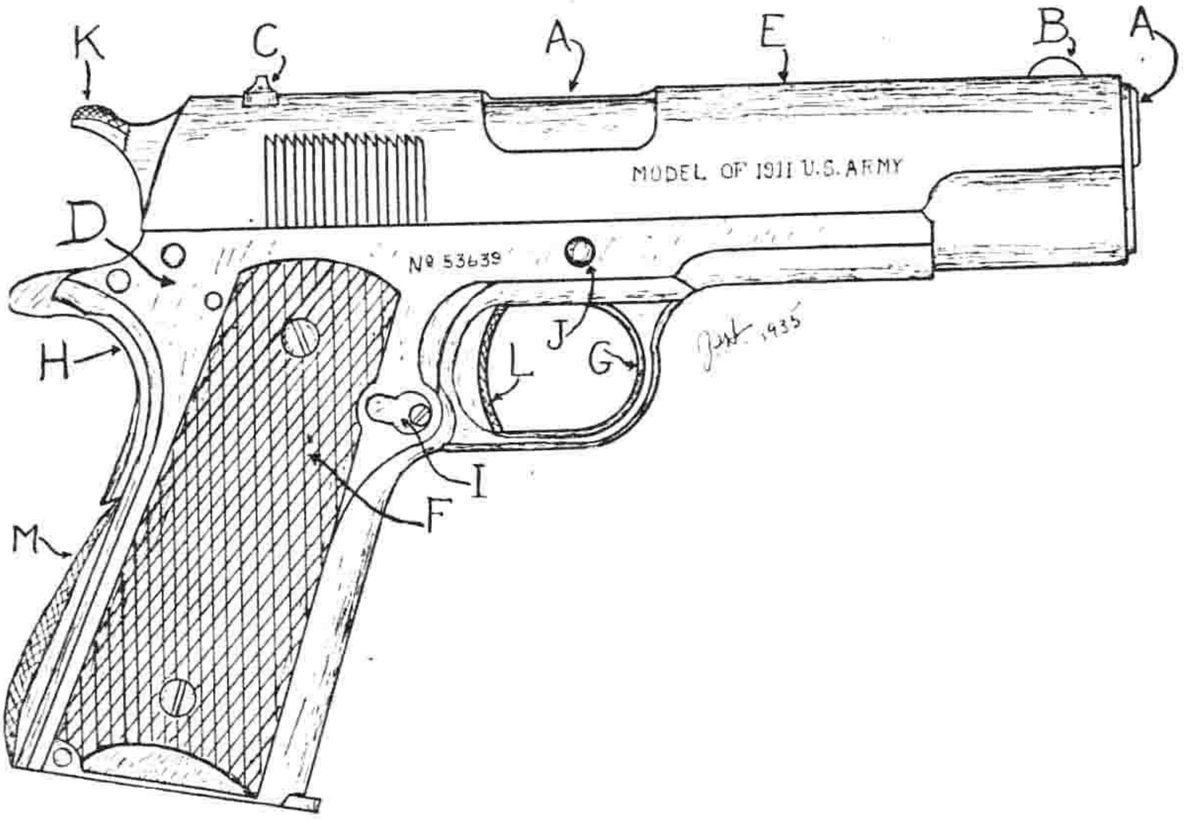


Showing the direction of file-marks or tool marks on revolvers and automatic pistols. Left, the breech face of a .45 caliber Government Model Automatic. Note that the tool marks are vertical, as the stroke of the tool had to be up and down through the ejection opening at the top of the slide. Cartridges fired in such a gun will have vertical striations impressed in the primer. Right, the breech face of a .45 Caliber Revolver, Model of 1917. Tool-marks or file marks cannot run up and down, as they do in the pistol, as the top and bottom of the frame prevent an up and down motion. The breech-face was finished by filing straight across, and the fired cartridge will have horizontal marks impressed on the primer.

Automatic Arms and Machine Guns

Besides the hand operated repeaters described above, there is another kind where the recoil or the gas pressure is utilized to open the breech after the shot is fired, at the same time ejecting the empty shell; a spring then closes the breech, and also puts in a fresh cartridge and leaves the gun ready to be fired by another pull on the trigger. When a gun of this kind is made so that it will keep on firing as long as the trigger is held down and the ammunition lasts, it is called a machine-gun or an automatic rifle, and is said to have a "full automatic" action. When it requires a fresh pull on the trigger for each shot, it is said to be an autoloader, or a self-loader, or a semi-automatic, and has what is called a "semi-automatic" action. The ordinary automatic pistol and the automatic shotgun are really not, strictly speaking, "automatics," but are more properly, semi-automatics, or self-loaders. The British call the .455 Webley a self-loader; the Winchester semi-automatic hunting rifle is called in the catalog a self-loader; the Remington Arms Co. call their semi-automatic rifles "auto-loading" rifles. The Government has the Browning rifle, with machine gun action, called, officially, the automatic rifle, and they also have the new Garand Self-loading Rifle, called officially, the Semi-automatic Shoulder Rifle. While semi-automatic pistols and semi-automatic shotguns will continue to be called automatics, it is well for the identification student to realize the strict meaning of the various terms given above, so that if the need ever arises, he can demonstrate that he really knows about such things.

There are a host of automatic pistols on the market at the present time. They come in various sizes and calibers, those commonly seen ranging from .25 caliber to .455. The most popular pocket sizes are the .25 caliber, the .32 caliber, and the .380, called in Europe, 6.35 mm., 7.65 mm., and 9 mm. short, respectively. There are about 150 different makes and models each of the .25 caliber and the .32 caliber automatic pistols, and there are perhaps 25 different .380 caliber pistols, so that it will be seen that the identification specialist would have his hands full in trying to tell from a fired shell of any of these calibers just what gun it came from. Still, much can be done by a proper examination and a knowledge of the characteristics of the various arms. Three German criminologists, Dr. Otto Mezger, Dr. Walter Heess, and Criminal Inspector Fritz Hasslacher, published a study on this subject, accompanied by a "Pistol Atlas" covering the three calibers mentioned above, and giving photographs and descriptions of the various arms, with full particulars of the various dimensions, drawings of the marks left on fired shells and bullets, etc. This Atlas could formerly be had from Dr. W. Heess, Forst Str. 18, Stuttgart, Germany, for 100 marks, and may or may not still be available, as there were only a limited number produced.



Example of an Automatic Pistol, or "Automatic"; the .45 Colt; official side arm of all U. S. forces. Its principal parts are: A—barrel, B—front sight, C—rear sight, D—frame or receiver, E—slide, F—grip, butt or handle, G—trigger guard, H—grip safety (there is also a thumb safety on opposite side which is not shown), I—end of magazine release, J—end of slide lock or catch (worked from opposite side), K—hammer, L—trigger, and M—mainspring housing.

Besides the three calibers of automatic pistol above mentioned, there are six others frequently seen in America. They are, the .22 rim fire, the Super .38, the .45 Automatic, the .30 caliber (7.63 mm) Mauser, the .30 Caliber (7:65 mm) Luger, and the 9 mm Luger. Note that while the .30 Mauser is called 7.63 mm, the .30 Luger is called 7.65, and that neither is the same as the common .32, or 7.65 mm, pocket pistol cartridge.

In the automatic pistol, from 7 to 10 cartridges are charged into a sheet steel magazine, which is then inserted into the hollow handle of the gun, so that the top cartridge lies just under the breech block. A spring in the magazine presses the cartridges upward. When the breech block is drawn backward, to load the gun, the breech block drags over the top cartridge in the magazine, and may scratch it. When the breech block is drawn all the way to the rear, it passes entirely beyond the top cartridge, which is then free to rise slightly, so that it will be partly in front of the lower edge of the breech block. As the breech block goes forward, it pushes the top cartridge forward, out of the magazine, and into the chamber. As it goes into the chamber, the rim of the cartridge will rise, so that finally it is behind the hook of the extractor, which is generally on the right of the breech block, but may be on top, or even on the left. In leaving the magazine, the cartridge must pass out in a forward and upward direction between two stiff and often sharp steel lips of the magazine, and most often it may receive scratches in doing so. When the gun is fired, the automatic action causes the breech to move rapidly to the rear, and the cartridge goes with it, until finally, near the rear of the breech recess, the rim that is opposite to the extractor strikes against the solid piece of metal placed there to serve as an ejector. This often puts a distinct dent in the head of the cartridge, and at the same time, causes the cartridge to pivot on its rim around the extractor, and be thrown out of the gun. Often it swings around so sharply in pivoting as described, that the mouth of the cartridge case may strike on the side of the frame of the gun, and be dented. When it pivots around the extractor, the front face of the cartridge rim usually receives a bruise, or mark. Thus it will be seen that the case from an automatic pistol has several opportunities to carry marks indicating the type of gun that may have fired it.

The top cartridge in the magazine is driven out of the magazine and into the chamber of the gun by the breech block in its forward motion, and sometimes the bottom edge of the breech block, which is the part that strikes the cartridge, will leave a mark on the rim. This is particularly the case when the breech block has a long stroke, so that it moves for some distance in its closing motion before coming in contact with the cartridge. This is the condition, for example, in the Thompson Submachine Gun, where the breech block has a very long travel, and is consequently moving forward quite fast by the time its bottom edge comes in contact with the top of the cartridge rim. Invariably the curved imprint of the bottom edge of the breech block can be seen on the head of a cartridge case ejected from the Thompson. On most automatic pistols, the breech block comes in contact with the top cartridge in the magazine almost as soon as it starts to move forward, and as it has not gotten up much speed at this time, the mark will usually be either very faint or not visible at all. However, it should always be looked for, as if it is found it will give an indication as to which way the cartridge lay in the gun, and may materially aid in determining what make of gun is involved.

Another thing about some automatic pistols that helps in this kind of identification is the fact that while most of the automatic pistol cases appear to be of the rimless type, very few of them are in fact rimless. The .380 and the .45 are truly rimless, and as they are straight cases, the only thing that keeps them from going all the way into the barrel is the fact that the front edge of the case is not crimped onto the ball, but instead is left sharp, so that it can strike against a shoulder at the front end of the chamber, inside. On the other hand, the .25, the .32, and the .Super .38 automatic cartridges, while they appear at first glance to be rimless, really have the rim slightly larger than the body of the case, and the slight projection of the rim beyond the body diameter stops the cartridge by striking against the edge of the chamber at the rear of the barrel. The cartridge is driven smartly to place by the closing of the breech block under spring action, and the surface that stops the cartridge is very small; as a consequence, the extreme edge of the front face of the rim on these semi-rim cartridges bears a bruised or marked space where the case bore against the rear end of the barrel.

Now the thing that makes this interesting is the fact that the rear end of the barrel is always cut away for one reason or another, such as for example, to make a space for the extractor, to form a feeding ramp at the bottom, etc. The cartridge has only a portion of the rear face of the barrel for its rim to strike on, and there will in consequence, be gaps in the mark above described, and these gaps will bear a certain relation to the extractor and ejector marks, depending on the make and model of the gun in question.

A very special mark, that will sometimes enable the investigator to say at once that the fired shell came from one particular make, is the fact that in the Savage automatic pistol, the barrel is revolved in going to the rear. Because the cartridge case is pressed very strongly against the breech block, it does not revolve, and as a consequence, the motion of the barrel as the cartridge is being withdrawn leaves spiral marks on the case. These marks make a right-hand spiral, and no other gun makes such marks on the case.

Machine Guns

The true *machine gun* is a fully automatic weapon, made to execute continuous fire with high powered rifle cartridges of the military type. In order to allow these long bursts of fire, it is necessary to supply the cartridges to the gun in such a way that a very large number of cartridges may be fired without reloading. The commonest method is to feed the cartridges into the gun in long belts of about 250 shots each. The belts, made of fabric, have loops to hold the cartridges, and they are stuck full of cartridges, and then the end of the belt is started through the opening in the gun, and the mechanism is worked by hand, which causes the first cartridge to be loaded into the chamber. Now when the trigger is pulled, the cartridge in the chamber is fired, and the recoil or the action of the gas pressure on a piston opens the breech, extracts and ejects the empty cartridge, and then draws a fresh cartridge from the belt and feeds it into the chamber, after which the breech is closed and locked. When the operation of locking the breech is completed, the firing mechanism is released, and the whole cycle starts over again, with no effort on the part of the operator except that of holding his finger on the trigger. When the trigger is released, the firing stops. The rate of fire for machine guns used on the ground is from about 350 to about 650 shots per minute, and for guns intended for use in airplanes, it is from 450 to 1200 or more shots per minute, depending on the make of gun. Not all of these guns are fed by belts as described above, for some are fed with steel strips holding thirty cartridges, some are fed with box magazines holding from 20 to 50 or more cartridges, and there are other methods of feeding them.

The heat of firing the cartridges continuously in this manner is tremendous and the barrel would get red-hot in a few minutes if something were not done to prevent it. For this reason, the machine guns intended for continuous fire on the ground usually have a water jacket surrounding the barrel to keep it cool; they are termed water-cooled guns. Some of these guns do not have a water jacket, but instead, use a very heavy barrel to absorb the heat, and make the barrel so that it may be changed quickly when it gets hot. These are called air cooled guns.

Machine guns used in the army, and intended for continuous fire, are quite heavy and bulky, and are usually mounted on tripods so that they look like small pieces of artillery. They are called Heavy Machine Guns.

Quite a different type of military machine gun is what formerly was called the Light Machine Gun, and is now called in our Army the Automatic Rifle or the Machine Rifle. The best known example is the Browning Automatic Rifle, which is a very heavy (15 lbs.) shoulder rifle with a full automatic action, and fed by a 20 round quick detachable magazine. When this rifle is fitted with a somewhat heavier barrel, so that it will stand more heat, and fitted with supports for the muzzle and breech, so that it can be rested on the ground, and fired by the man lying behind it, it is called a Machine Rifle.

At the present time, this gun is made and sold commercially to law enforcement agencies by the Colt's Patent Firearms Company, under the name of the Colt "Monitor," which differs from the Browning Automatic Rifle used in the Army only in the fact that there are a few small changes in the stock and the external mechanism, and that there is a Cutts Compensator added on the end of the barrel to keep the muzzle from rising from the continuously repeated recoil which occurs when full automatic fire is used.

Both the Monitor and the Browning Automatic Rifle may be used for either full automatic fire or for semi-automatic fire, at the will of the operator, depending on the position of the control lever, or "change lever" on the left side. When the lever is set to the semi-automatic position, the gun will fire every time the trigger is pulled, but the trigger has to be released and pulled again for each shot desired. When it is set to the automatic position, the gun will fire continuously as long as the finger is held on the trigger and the ammunition lasts. As there are only 20 shots in a magazine, and the gun fires at the rate of from 400 to 600 shots per minute, it will be seen that one magazine will last only about two or three seconds at the most, when full automatic fire is being used. It is intended that a number of loaded magazines should be kept on hand, and when a magazine is empty, it can be dropped out instantly by pressing a catch, and another one can be inserted in a fraction of a second.

The outlaw, Clyde Barrow, had in some way obtained three Browning Automatic Rifles, and at the time he was shot to death with his companion, Bonnie Parker, by peace officers, he had a loaded Browning Automatic rifle in his automobile. One of the Brownings he used had been cut down by sawing off the muzzle of the barrel and part of the stock. As this case will show, the Browning Automatic Rifle is likely to be used by gangsters and outlaws, and the Monitor is being used at the present time by police departments and law enforcement agencies, including the United States Department of Justice. Therefore it behooves the firearms expert to know as much as possible about such weapons.

The Browning Automatic and the Monitor use the extremely high powered .30 caliber Government cartridge, the same as is used by the Army in the Springfield rifle. These guns have a very large and heavy firing pin, and make a much deeper and wider dent in the primer than is made by the ordinary shoulder rifle. They have an extractor with a wide claw, and this extractor has to spring over the rim of the cartridge when it is in the chamber and the bolt is closing. The gun opens with great energy, and the head of the cartridge strikes against the ejector with a considerable degree of force, so that the ejector leaves a dent in the head. During ejection, the empty case pivots around the extractor claw and is thrown against the side of the gun, and thus receives a noticeable dent. Moreover, the claw of the extractor makes a distinctive mark on the rim. For all these reasons, it is quite easy to tell the empty from a Browning Rifle when it is encountered, and the student should learn to distinguish it from the empty from an ordinary rifle.

The Submachine Gun

With the exception of the Browning Automatic Rifle and the Monitor, high powered machine guns are not likely to figure in the work of the firearms identification specialist, but machine guns using pistol cartridges, or *submachine guns,* as they are officially called, have been much involved in crimes of violence during the past few years. These weapons were first introduced in Europe during the World War, and were then called machine pistols. Their use by gangsters, and the publicity that they have received through the moving pictures and newspaper items has made the term "machine gun" a familiar one with the sensation loving public, most of whom have no idea that there is any other machine gun except the sub-machine gun. In fact, most of them do not know that there is such a thing as a sub-machine gun, and suppose that the machine guns which are used by the gangsters are the same large machine guns that were used by the army during the war.

The first sub-machine gun ever seen by the author, and as far as he knows, the first one to be regularly manufactured, was the Villar Perosa, which he tested at the Springfield Armory in 1917. This gun used the 9 mm Luger pistol cartridge, and was proposed at that time for the armament of airplanes. The next weapon of this class was the Bergmann Maschinen-Pistole, used by the German Army near the close of the World War. This gun looks much like a short rifle, as it has a barrel jacket that is much longer than the real barrel. It also used the Luger Pistol Cartridge. It is now used by several European police forces.

Soon after the close of the World War, a similar weapon was designed in this country, and almost immediately became prominent as a favorite weapon of the underworld gangs. This is the Thompson sub-machine gun, made to use the regular .45 automatic pistol cartridge. This is the "machine gun" that so often appears in the news of gang murders, etc. This murderous contrivance is light and easily handled, as it weights only 8½ lbs., and is but 23¼ inches long, without the shoulder stock. It has a barrel that is 10½ inches long, and gives a muzzle velocity of 918 feet per second with the standard .45 pistol cartridge. The cartridges are fed to the mechanism by either a 20 round box magazine, or by a 50 or 100 round drum magazine. Weight of 5 box magazines, empty, 2 pounds; loaded, 6.6 pounds. Weight of the 50 round drum, empty, 2.5 pounds; loaded, 4.8 pounds. Weight of the 100 round magazine, empty, 3.9 pounds; full, 8.5 pounds.

The gun may be used for either full automatic or single shot, (semi-automatic), fire as desired, and there is a lever which may be set so that either type of fire will be obtained. The sight is graduated up to 600 yards, and the maker of the gun states that the effective range is 350 yards. However, the extreme range is a mile, and the gun may kill at this distance if a hit should by any chance be made.

The rifling is similar in form and dimensions to that in the Colt Automatic Pistol, and the pitch is the same, that is, one turn in 16 inches; but the direction is opposite to that in the Colt, or right handed.

Recently, certain manufacturers and others have been converting automatic pistols of the large military type to full automatic action, and fitting them with extension magazines and shoulder stocks, thus virtually making them into sub-machine guns. The Mauser automatic pistol, military model, is now regularly made in this type by the original makers. It was such a Mauser Machine Pistol that was used in the recent regrettable assassination of King Alexander of Jugo-Slavia in Marseilles. An exactly similar machine pistol is made in Spain under the name "Astra." Bonifacio Echeverria, in Eibar, Spain, makes a gun called the "Star" which exactly resembles the Colt Super .38 and the Colt .45 automatic in design and appearance. This gun, in either caliber, is furnished as a machine-pistol, with wooden holster-stock, and extension magazine. For the .38, magazines holding 16 or 32 cartridges can be had, and for the .45, the magazines hold 13 or 25 cartridges. These extension magazines for the Colt .45 automatic are now beginning to be sold in the United States, and gangsters are converting the .45 to a machine pistol. The Luger, fitted with shoulder stock and extension magazine, and changed over to machine gun action, has also been on sale.

All such machine-pistols, or sub-machine guns, come under the provisions of the Federal Firearms Act of June 26, 1934, which imposes a tax of $200 on each sale or transfer of any such weapon. The possession of any such gun, except by a law enforcement agency or some other authorized person, should be regarded as a strong indication of guilt, or of intention of guilt.

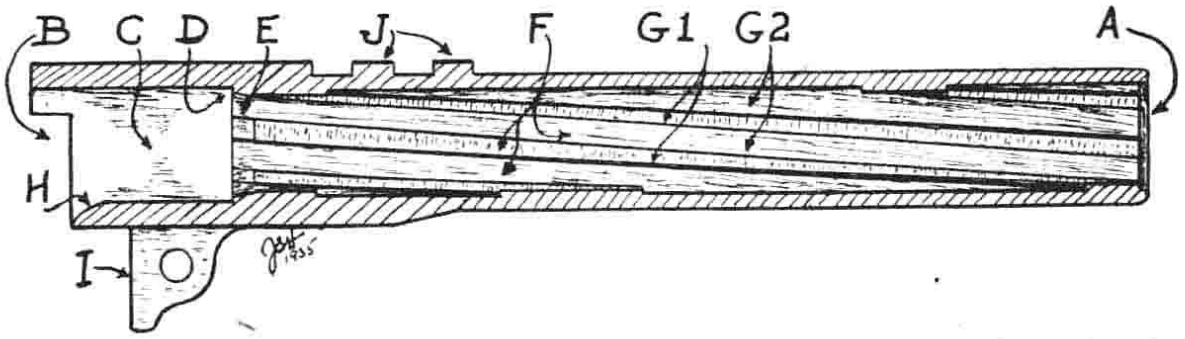
Rifling

All of the weapons mentioned above, except the shotgun, are rifled; that is, they have a series of spiral grooves cut into the surface of the barrel, for the purpose of spinning the bullet, to give it more accuracy and to keep it end-on throughout its flight.

In making a rifled barrel for any firearm, the first operation is to bore a hole all the way through the piece of steel that is to be used to make the barrel; the next thing is to ream this hole to an exact size and make it as smooth as possible inside. The diameter of this smoothly reamed hole, or the *bore diameter* is called the *Caliber* of the gun, and is expressed in hundredths or sometimes in thousandths of an inch, or in millimeters. Thus the U. S. Army Springfield Rifle has the bore reamed to as nearly .300 inch as is possible, and in consequence, this is called a .30 caliber rifle.

After the hole is bored and reamed to size, it is usually very smooth in appearance to the unaided eye; but when the apparently smooth surface is looked at with a microscope, it will be seen to have a number of scratches on it, left there by the reamer, or perhaps by small chips of metal caught between the edge of the reamer and the metal of the barrel. These scratches are circular in direction, going round and round inside the barrel in the same direction that the edges of the reamer followed in the smoothing operation.

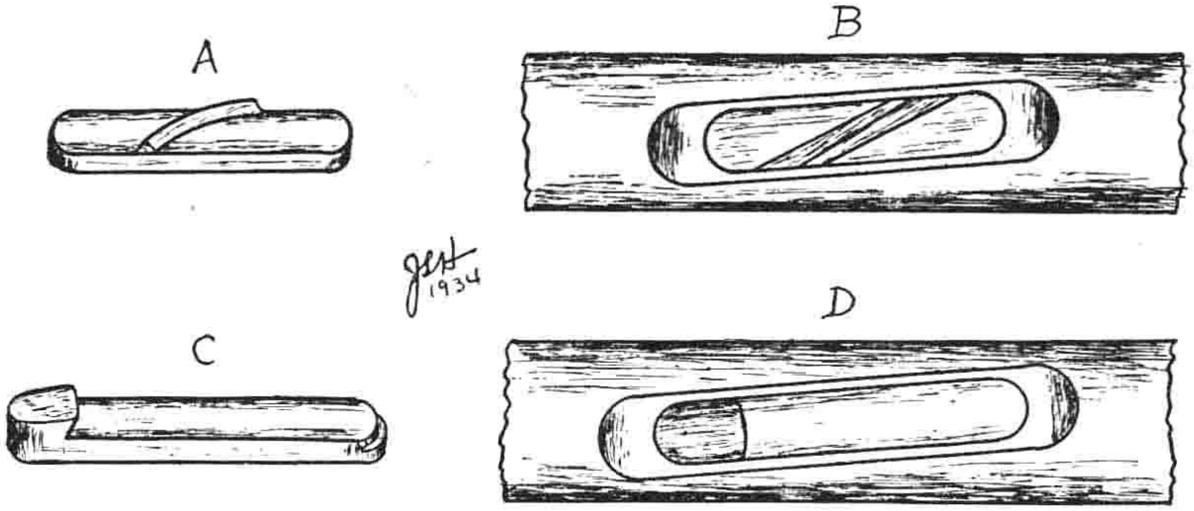
The next thing is to put in the rifling. This is done by cutters carried by a long rod of steel, nearly the same size as the reamed hole through the barrel. These cutters are carried at one end of the rod in such a manner that when the rod is pulled through the barrel, the cutters project up above the surface, and make a scratch on the inside of the barrel; or more properly, we should say, the cutter scrapes away a fine layer of the metal as it is drawn through the bore. If the rod were simply pulled straight through, without being turned at the same time, the cutter would leave a straight groove; but what is wanted is a spiral groove, so the rod is turned as it is pulled through. The cutter is mounted in a slot in the rod, and has a wedge under it inside the rod, which holds it so that the edge projects beyond the surface of the rod. After the first cut is made, this wedge is pushed in slightly, so that the cutter is pushed up a little further above the surface. Thus it will cut the groove deeper on the next stroke. In the Springfield rifle, the grooves are four thousandths of an inch deep, and the cutter takes 80 strokes to finish a groove, so that the amount of metal removed each time is only one twenty thousandth of an inch. The cuts are made so fine because it is desired to keep the surface as smooth as possible, and if deeper cuts are taken, there is danger of tearing the metal, and so leaving a rough surface.



Cross section of the entire barrel of the .45 Automatic Pistol. A—muzzle, B—breech, C—chamber, D—shoulder, E—lead (leed) or throat or bullet seat or forcing cone, F—bore, H—ramp, I—barrel lug and J—locking lugs, G1 designates the lands and G2 the grooves of the bore.

There are two different ways of making rifling cutters, depending upon the desires of the manufacturer. One kind, which makes a very smooth barrel, is called the scrape cutter. With the scrape system of rifling, the cutters are in sets of two, one on each side of the rifling rod, so that two sets of grooves are cut at a time, one on one side of the barrel and the other directly opposite.

When a stroke has been made, the rifling rod is "indexed" or turned through one fourth or one sixth, or perhaps one eighth, of a revolution, depending on whether the barrel is to have four, six, or eight grooves, and another set of grooves is started. Thus the rifling rod makes a stroke, taking off a half a ten-thousandth of an inch of metal; then it is indexed to the next groove, and passes through this, again taking off a fine scraping; and so on, taking one stroke in each groove, around and around the barrel, until each groove has the required depth.



RIFLING CUTTERS.

A Blade of a "scrape" rifling cutter.

B Scrape cutter in place in the rifling head at the end of the rifling bar. There is another cutter exactly like this on the opposite side of the rifling head, as with the "scrape" system, two opposite grooves are rifled at the same time. The cutters are arranged to work in both directions, and take a shaving of metal off the bore on both the "push" and the "pull" strokes of the rifling bar. The "scrape" system is used only when an even number of grooves are being cut

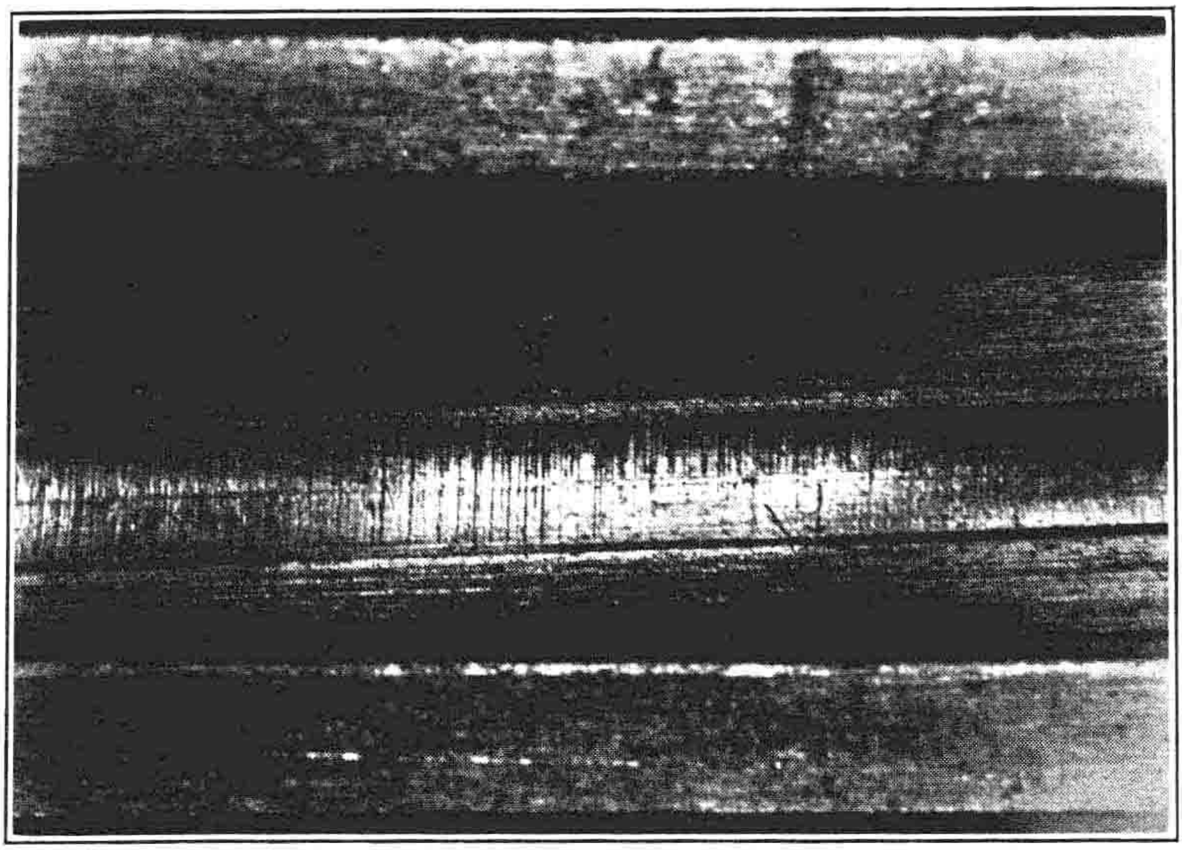
C Blade of a "hook" cutter.

D Hook cutter in place in the rifling head. There is no cutter opposite this one, because with the "hook" system, but one groove is rifled at a time. The cutter only works in one direction, as it is being pulled through the bore. This is the system which must be used when an odd number of grooves are being cut.

The finished grooves are usually about four thousandths of an inch deep, though some makers use shallower grooves, and some deeper ones. The spiral strips of the original bore, left between the grooves, are called *lands*.

In the case of the hook cutter, only one set of cutters is used in the rifling rod; there is no set opposite. The hook cutter is used when 5, 7, or any uneven number of grooves is made. It may also be used if desired, for barrels having an even number of grooves. Hook cutters work more quickly than scrape cutters, but in general are likely to leave a somewhat rougher surface.

These rifling cutters are honed to a very smooth edge, and the effort is made to have the grooves finish up with a surface that is as smooth as possible; but there are always some scratches left. These scratches are due to several things; they may, for example, be caused by small chips caught under the edge of the cutter and dragged along with it; but even if there are no chips, there is another cause of this roughness, and that is the fact that in any machining operation, the metal that is removed is actually *torn* away from what remains, and this tearing operation is always irregular, and invariably results in leaving little rough spots, furrows, grooves, and ridges, in the surface, and the size and character of these rough spots depend on the shape and sharpness of the tool, the hardness of the material, the speed with which it is cut, etc. Sometimes, too, a little nick may occur in the edge of the cutter, and this will leave a ridge in the surface. Such a ridge is, however, likely to be repeated in all the grooves of the barrel that are rifled by that cutter, and even in other guns that are rifled about the same time. For that reason, ridges of this kind are not as valuable for definite identification of bullets as are the little irregularities due to the tearing of the metal when it is being machined away.



A microphotograph of the inside of a revolver barrel by Capt. Crossman, showing that the inside of a gun barrel is usually not as smooth and polished as it appears to the eye. Note the transverse tool marks on top of the land, and the longitudinal scratches on the bottom of the grooves.

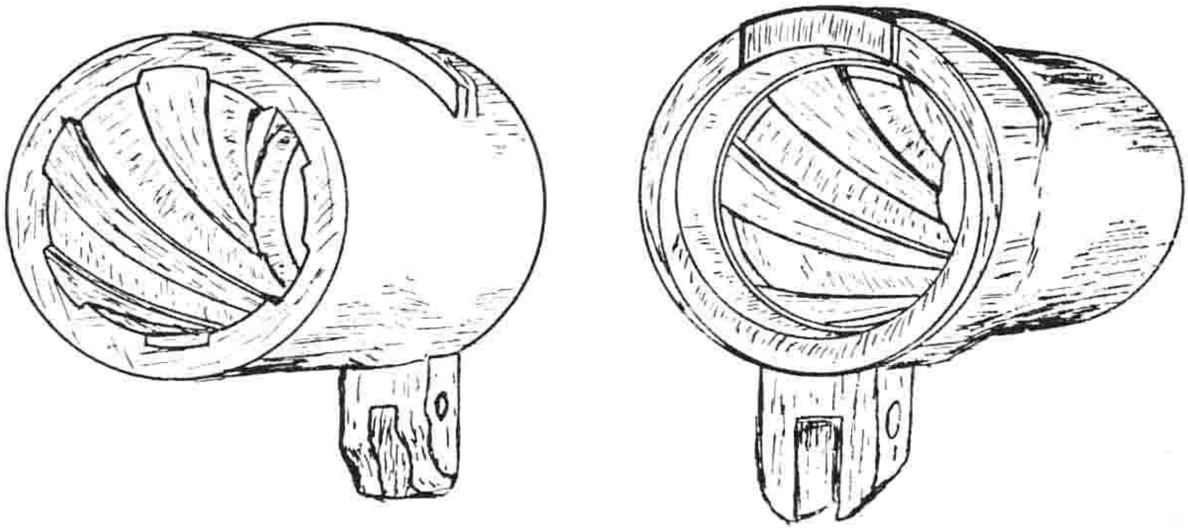
The scratches and ridges and furrows on the bottoms of the grooves run lengthwise of the barrel, that is, parallel to the direction of the groove; while the scratches on top of the lands run across the lands instead of lengthwise, for these scratches are the remains of the circular scratches, concentric with the bore, that were made by the reaming operation.

Every big firearms company has a standard set of drawings according to which they are supposed to make their rifling. Thus by consulting these standards, we should be able to know the width of the lands, the width of the grooves, the depth of the rifling, the pitch of the rifling, etc., and in theory, if we have a crime bullet, we should, by an examination of it, and a careful measurement of all these things, learn a lot about what make of gun it was or was not fired from. Much can actually be done along this line; but the student of identification who expects too much from this kind of investigation will very likely be disappointed, for there are many difficulties in the way.

Take the matter of twist of rifling, for instance. Ordinarily, the twist is given by the action of a cam roller working in a guideway or slot on an arm which may be clamped at a desired angle with the axis of the machine. If the machine is taken down for repair or adjustment, a hasty setting of this angle may result in quite a different twist from the standard. The author has seen noticeable variations from this cause. Then in the matter of the width of the grooves, there are even more chances for variation, for the cutter is often finished by hand, and any variation of it will give a wider or narrower groove; and naturally any variation in the groove width will also affect the width of the lands. Then, also, when the rifling bar is advanced through the barrel, the edge of the cutter has a tendency to drag on one side of the groove; on the other hand, when the cutter is withdrawn, the opposite edge drags. This has a tendency to make the groove wider than intended, and if any chips of steel, etc., should get in the way, this action might be increased. Sometimes, even in high grade arms, there is a variation in the width of the grooves in the same gun.

As to depth of grooves, there are also likely to be variations. Often in honing the cutter, it will not be made concentric, and one side of the groove may thus be deeper than the other side. Moreover, the steel in the barrel is not always uniform, and it is not uncommon to strike harder and softer spots, with corresponding variations in depth.

The *direction* of twist may be right-handed or left-handed. A right-hand twist is one in which the grooves in the top of the bore, or on top of the fired bullet, slant to the right as they go away from the observer. This slant will be the same whether the gun or bullet is viewed from the muzzle end or the breech end. Most makers use a right hand twist; however, Colt in America, Bayard in Belgium, and several Spanish makers use left hand twists. There is no advantage in either twist over the other, but the fact that Colt uses a different twist from S & W and the other American makers is a great aid to the cause of justice, for it takes no costly instruments or expert training to distinguish between the two, and very often this difference is the starting point for the solution of what otherwise might be a puzzling crime.



The sketch on the left represents a view into the muzzle end of a barrel from a .45 Caliber Colt Automatic Pistol, showing the appearance of the rifling, while the sketch on the right shows the same barrel viewed from the rear end. Note that the left-hand rifling appears to slope in the same direction whether it is viewed from the muzzle or from the breech.

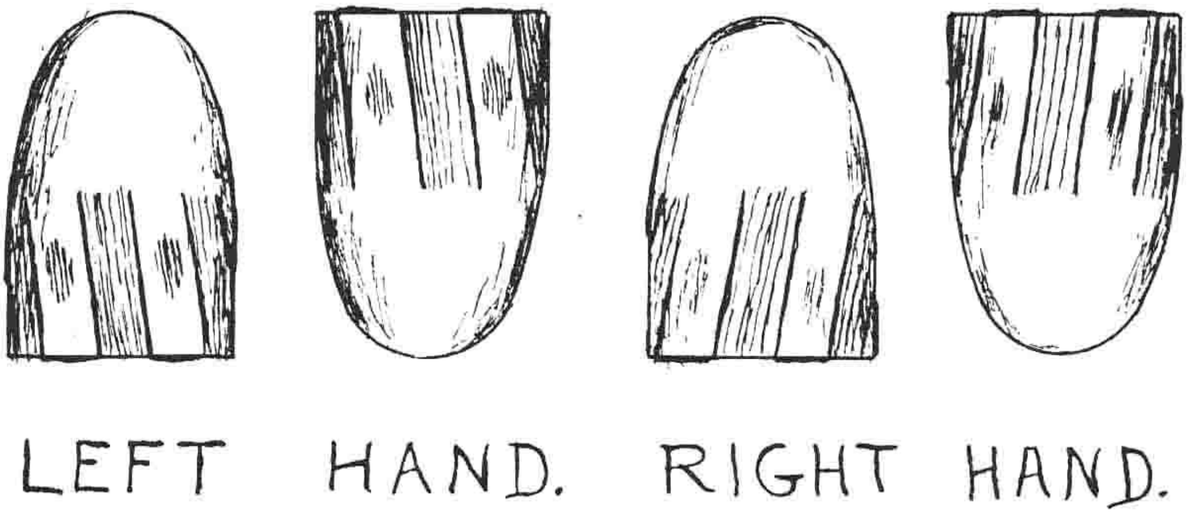
The Pitch of the Rifling

One of the very important dimensions of the rifling in any arm is its *pitch,* or the amount that it advances for each complete turn. This is usually given as so many inches per turn or so many centimeters per turn; and rifling is described as having one turn in so many inches or centimeters. Thus, the .30 caliber Army Springfield Rifle has one turn in ten inches.

Bullets fired in rifled arms are usually about a thousandth of an inch larger than the diameter across the grooves of the arm in which they are to be used. This means that they are larger than the diameter of the bore. Thus, the .30 caliber bullet will be larger than .30 inch, for the bore of the rifle is that size, and the grooves are .004 inch deep, so that the diameter across the grooves is .308 inch. The bullet is between .308 and .309 inch in diameter.

This means that the lands cut into the surface of the bullet, and the metal of the bullet fills the grooves in the rifle, so that the fired bullet has rifling marks on it just like those in the gun, except that on the bullet the land marks are depressed, and the groove marks are raised.

Moreover, the bullet will be just the same size as the barrel from which it was shot, for if it were larger, it would be squeezed down to the bore size, and if it were smaller, it would be "upset" or expanded by the gas pressure so that it would fill, or nearly fill, the grooves. Sometimes the jacketed bullets, if they happen to be fired in a gun that is too large for them, do not fill the bottom of the grooves completely, but at least it can be told by looking at the bullet whether or not it has filled the grooves, and therefore, whether or not the bullet will be the exact diameter of the barrel from which it was fired.

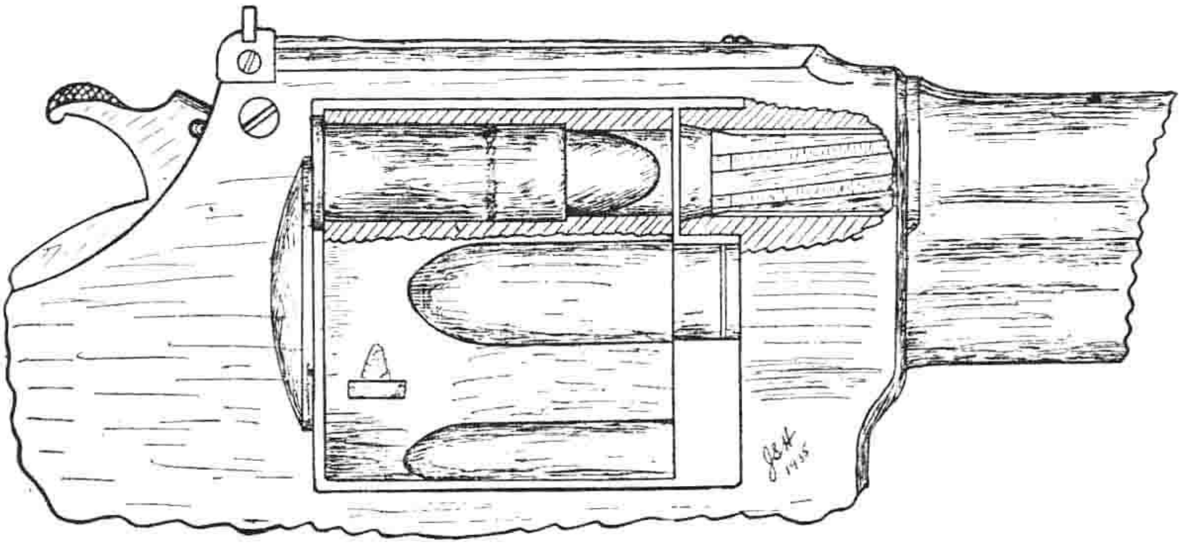

LEFT HAND.
RIGHT HAND.

This drawing shows how to tell from the rifling marks on the fired bullet whether the weapon from which it was fired had right hand or left hand twist. Note that on the bullet from the gun with right hand twist the rifling marks slope to the right as they go away from the observer, and on the one from the gun with left hand twist, the marks slope to the left; and this is true whether the bullet is viewed from the front end or from the rear.

Theoretically, at least, the pitch of the rifling marks on the bullet should give an excellent indication as to the make of the gun from which the bullet was fired, for the pitch differs very greatly among the different makers, and when two makers do happen to use the same pitch of rifling, some other measurement, such as the width of the lands, for example, is usually different.

Practically, however, the difficulties in the way of measuring the pitch of the rifling on recovered bullets are so great that very few investigators even attempt to measure it. It is quite easy to measure the pitch of rifling on the inside of a rifled barrel, and there is an instrument on the market which was made specifically for that purpose, as will be described later; but on the recovered bullet it is a different and much more difficult matter.

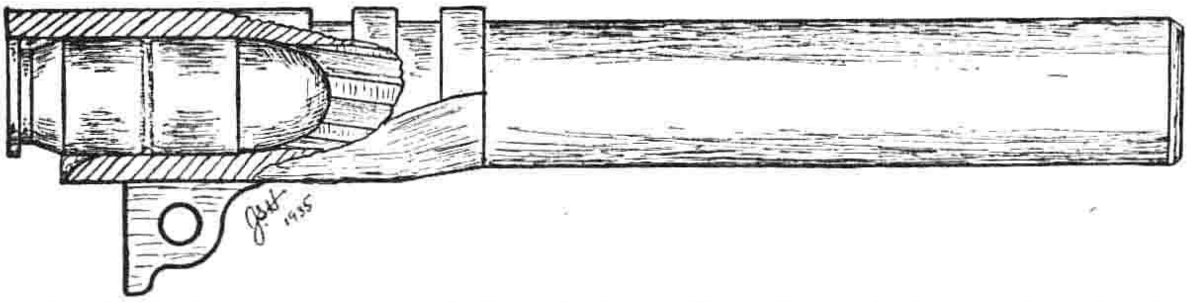
For one thing, many bullets are short, and have an even shorter bearing in the rifling, so that the marks left on them are short. And even if the marks were longer, only a certain short portion of them can be used for the measurement, for the angle of a helix changes from one edge of the bullet to the other when it is viewed from the side, as will be made plain by examination. But a much more serious difficulty is the fact that many crime bullets are much distorted, and even where the bullet has not struck any hard object, a serious distortion may occur in the arm itself, from the fact that the bullet may tip to one side or the other in passing from the cylinder of a revolver to the barrel, and this tipping may cause the angle of the rifling to vary from one side of the bullet to the other. For this reason all the lands should be measured and the average angle taken, when an attempt is made to identify a bullet from its pitch of rifling.



Sketch of the manner in which a revolver cartridge chambers in the cylinder; note that bullet lies in an unrifled section of the cartridge chamber and must jump an appreciable gap before it strikes the rifled section of the revolver barrel. Bullet first travels through front end of chamber, then through "cone" into lead before it enters the rifled section of the barrel. Above rifling has a right-hand pitch. Sketch illustrates cartridge in Smith & Wesson .38/44 Outdoorsmans Revolver.

Another thing that affects the marks left on the bullet is what is known as slippage. When the rifling is badly worn, or when the bullet is small, or too soft for the velocities used, there is a tendency for it to go straight forward without turning, and it jumps the rifling, or slips. In a bad case of this kind, there may be no rifling marks at all on the bullet, and in a mild case, the land marks will be wider than they should be.

When a rifled gun wears out, it is the rifling in the breech end of the barrel that shows the first effects. The breech may be worn nearly smooth before the rifling in the muzzle suffers much, and in such a gun, the marks on the bullet may present a bad mess for the identification specialist. In the first place, the bullet will fit loosely, and may turn more or less sideways before it hits the good rifling. In the second place, the smooth lands near the breech will not take hold of the bullet, and it will jump them, until finally it begins to be turned by the sharper lands near the muzzle. The resulting blurring, indistinctness, and jumbling of the marks can well be imagined.

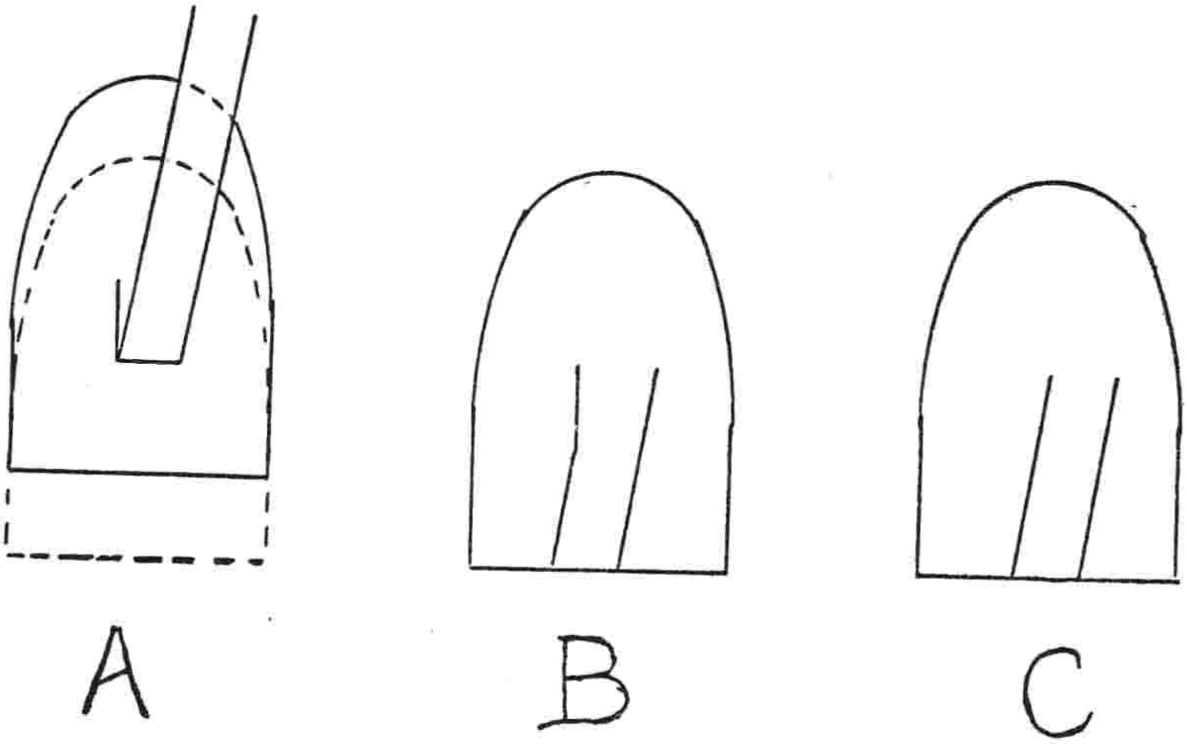


Sketch of the manner in which the .45 Automatic pistol cartridge chambers in the barrel; note that bullet is seated up into the throat of the bore, bearing right against the rifling before the cartridge is fired. Twist of rifling is left handed.

There is still another effect, known as skidding. When the bullet first starts forward, even if the gun is new and the lands are sharp, the bullet tends to go straight forward without turning, and the rifling has a tremendous task to start the bullet spinning at a rate of over three thousand rotations a second, as it does in the Springfield rifle. The result is, that before the bullet can begin to turn, it moves forward a small amount, and this makes the front of the groove in the bullet wider than the rear part. This skidding is more pronounced in revolvers than it is in rifles and pistols, for in the rifle or pistol, the bullet encounters the rifling at the very beginning of its movement, while in the revolver, it moves forward in the cylinder a half inch or more before it enters the barrel and encounters the rifling, and in this half inch of motion it can get up quite a large forward velocity.

In spite of these difficulties, there are some investigators who have done a lot of work in measuring the angle of the rifling on fired bullets, and for that reason it is well to have on hand as much data as possible as to the different twists used by the various makers. And of course, the direction of the twist, and the width of the lands and grooves should be tabulated. Some of this material is easily available in catalogs and handbooks, and is already common knowledge among those interested in firearms.

For example, almost everyone who is at all interested in guns knows that all modern American made pistols or revolvers except those made by the Colt's Patent Firearms Manufacturing Company have a right-hand twist to the rifling, and that the Colt guns are left-handed; that Colt uses six lands and grooves, while Smith & Wesson use five in most of their models; also that Colt guns have wide grooves and narrow lands, while the Smith & Wesson guns usually have lands and grooves of equal width.



HOW "SKID MARKS" ARE CAUSED

Frequently it will be observed that the marks left by the lands are wider at the top than at the bottom, as shown at B. This is caused by the fact that when the powder charge explodes, the bullet jumps straight forward until it strikes the rifling, when it is suddenly forced to take up a motion of rotation. Very often, when it strikes the origin of the rifling, it "skids" straight ahead a short distance before the motion of rotation begins. This is shown diagrammatically at A. The lands plow straight back into the bullet material for a short distance before the motion of rotation begins, and thus cause the straight mark shown at the top of the trailing edge. "Skid marks" are likely to be much more pronounced in revolvers, where the bullet is already travelling forward very fast before it reaches the rifling, than in pistols, where the bullet is practically in contact with the rifling as it lies in the chamber. Very often in a rifle or pistol, when the bullet is in contact with the lands before the motion starts, there will be no skid marks, and the rifling marks will appear as shown in C.

The investigator will find himself very much concerned with the very large number of pocket automatic pistols of .25 A. C. P.

or 6.35 mm, .32 A. C. P. or 7.65 mm, and of .380 A. C. P. or 9 mm short, calibers. Most of these pistols have rifling with right hand twist; as was mentioned above, however, the Colt pistols, the Bayard, and several of Spanish make have left handed rifling. As far as is known to the author at this time, all pistols with left hand rifling have six lands and grooves.

In fact, in all these pistols it is most common to find six grooves, though about one fourth of the .25 caliber pistols and one third of the .32 caliber have four grooves. Automatics with five, seven, or eight grooves are comparatively rare. Pistols having five grooves include the Express, the F. N. Model 1900, the Gloria, the Harrington & Richardson, the Melior and Stenda .32, the Pickert, the Princeps, and the Waldmann .25. There is just one each of the pocket calibers having 7 grooves, and those are the Remington Model 51 in the .380 and .32 calibers, and the Delu .25. There is only one with 8 grooves so far as is known, and this is the Schmeisser .25 Cal. Model 2, with serial number over 105,000; guns of this type with lower serial numbers have six grooves.

In a later chapter of this book, the exact standard dimensions covering all these things for many makes and models of revolvers and pistols are carefully tabulated. The elementary investigator will find this tabulation extremely valuable as a reference. Very frequently it will enable the expert to say with certainty what make or makes of gun the fatal bullet *did not* come from. It is hard to say with assurance that a bullet positively did come from a gun of a certain make, for there are a myriad of Spanish and other foreign makes of hand firearm with almost every kind of rifling imaginable, and if, for example, our bullet shows lands and grooves correct for a Smith & Wesson, they may also be the same for some foreign pistol not listed.

While, as noted above, many detailed figures are given in another chapter, the following condensed tabulation may be found useful for quick reference:

Smith & Wesson

The first model .22 caliber Smith & Wesson, with the barrel that turned up to load, had 3 grooves, left-hand. However, all modern Smith & Wessons have a right-hand twist with lands and grooves equal in width, and 5 grooves in all except the caliber .22, the .32 and .35 automatics and the .45 Model 1917 which have 6

PITCH OF RIFLING AS FOLLOWS:

.45 Schofield	1 turn in 24 inches
.45 Colt	1 " " 20 "
.45 M1917	1 " " 14.659 "
.44 Caliber	1 " " 20 "
.38 Winchester (.38-40)	1 " " 20 "
Other .38 Calibers	1 " " 18¾ "
.32 Calibers, except .32 Winchester	1 " " 18¾ "
.32 Winchester (.32-20) and .32 and .35 Automatics	1 " " 12 "
.22 Caliber	1 " " 10 "

Depth of grooves from .003 to .006 according to caliber and model.

Colt

Some of the early percussion models had seven grooves, right-hand twist. Many of the early metallic cartridge models, in both rim and center fire, had 7 grooves, left-hand twist. However, all modern Colt revolvers and automatic pistols have a left-hand twist with 6 grooves. The grooves are approximately twice the width of the lands; the bore somewhat smaller than the Smith & Wesson to compensate for wider grooves. Groove depth .0035 inch. The pitch is 1 turn in 16 inches in all models except the .22 which is 1 turn in 14 inches.

Iver Johnson

Some earlier models had 3 grooves, right-hand twist. However, all the latest ones have 5 grooves .005 inch deep, and resemble the Smith & Wesson in general appearance. In some cases the land and groove are equal, while in other cases the land may be considerably wider than the groove. In the .22 caliber the pitch is 1 turn in 15¾ inches; in the others it is 1 turn in 23-1/3 inches.

Harrington & Richardson

Right-hand twist, with pitch 1 turn in 12 inches, except for the .22 target pistol, which is 1 in 16. Now has 6 grooves in all models, approximately .003 or .005 inch deep. Formerly the .32 and .38 revolver and some of the automatic pistols had 5 grooves.

Savage Automatic Pistol

Six grooves .003 inch deep, right-hand twist. 1 turn in 12 inches for the .32 and .380 automatic pistols, and 1 turn in 16 inches for the .45 pistol of which a few were made for the Army.

Remington Automatic Pistol

Seven grooves, right-hand twist, .0035 inch deep, 1 turn in 16 inches.

Thompson Submachine Gun

Six grooves, .0035 inch deep, right hand twist. Grooves are approximately twice the width of the lands.

Angle of the Rifling

On a recovered bullet, all that we see that gives a clue as to the twist of the rifling in inches per turn is the angle that the rifling marks make to the axis of the bullet. A little calculation will show that for a forward advance of a number of inches equal to the pitch, the groove advances sideways an amount equal to the circumference of the bullet; e.g., in the Colt gun, with a twist of one turn in 16 inches, the groove goes all the way round the circumference while it is advancing 16 inches. If this is laid out in the form of a diagram, it will be seen that the rifling forms an angle whose tangent is π times the diameter of the bullet, divided by the pitch; or if we call the angle of the rifling Θ, then

$$\tan \Theta = \frac{\pi \times \text{bullet diam.}}{\text{Pitch}} \text{ and, conversely,}$$

$$\text{Pitch} = \frac{\pi \times \text{bullet diameter}}{\tan \Theta}$$

Thus, given the angle of rifling, and the diameter of the bullet in inches, to find the pitch of the rifling in inches, first look up the natural tangent of the angle in a table of trigonometrical functions, and then multiply the diameter of the bullet by 3.1416, and divide the result by the tangent already found. For example, suppose we have a .45 caliber bullet, with a rifling angle of 5° 04′, and a diameter of .451 inch. The tangent of the angle is found to be .885, and the circumference of the bullet is 1.416, which divided by .885 gives 16 inches as the twist.

For the convenience of the student, a table showing the angle of rifling corresponding to various bullet diameters and twists is given in the tabulation following:

ANGLE OF RIFLING WITH AXIS OF THE BULLET FOR VARIOUS TWISTS AND CALIBERS.

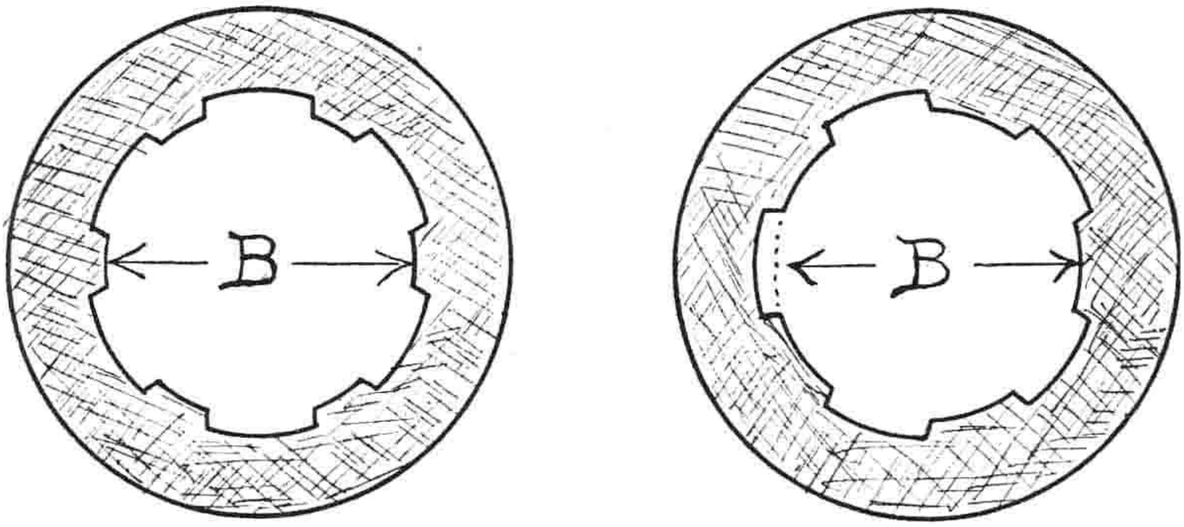
Caliber of bullet	Diameter of bullet inches	Twist of the rifling in inches per turn					
		7	7.875	9.4	10	12	14
.22	.223	5°43′	5°05′	4°15′	4°00′	3°21′	2°52′
.25	.250	6°24′	5°42′	4°46′	4°29′	3°45′	3°13′
30	.309	7°54′	7°01′	5°52′	5°32′	4°38′	3°58′
.32	.314	8°01′	7°08′	5°58′	5°38′	4°42′	4°02′
9mm	.354	9°01′	8°02′	6°43′	6°21′	5°18′	4°32′
.38	.359	9°11′	8°09′	6°49′	6°26′	5°52′	4°37′
.38-40	.400	10°10′	9°04′	7°35′	7°10′	5°59′	5°08′
.41	.406	10°20′	9°12′	7°42′	7°16′	6°04′	5°12′
.44	.431	10°57′	9°45′	8° 0′	7°43′	6°26′	5°31′
.45 auto.	.451	11°27′	10°12′	8°33′	8°04′	6°44′	5°47′
.45 Colt	.455	11°32′	10°17′	8°37′	8°08′	6°47′	5°50′

ANGLE OF RIFLING WITH AXIS OF THE BULLET FOR VARIOUS TWISTS AND CALIBERS.

Caliber of bullet	Diameter of bullet inches	Twist of the rifling in inches per turn							
		14.659	15	15.75	16	18.75	20	23.33	24
.22	.223	2°44′	2°40′	2°32′	2°30′	2°08′	2°00′	1°43′	1°40′
.25	.250	3°04′	3°00′	2°51′	2°49′	2°24′	2°15′	1°56′	1°53′
.30	.309	3°47′	3°42′	3°32′	3°28′	2°58′	2°47′	2°23′	2°19′
.32	.314	3°51′	3°46′	3°35′	3°32′	3°01′	2°49′	2°25′	2°21′
9mm	.354	4°20′	4°14′	4°02′	3°59′	3°24′	3°11′	2°24′	2°39′
.38	.359	4°24′	4°18′	4°06′	4°02′	3°26′	3°14′	2°46′	2°41′
.38-40	.400	4°54′	4°46′	4°34′	4°29′	3°50′	3°36′	3°05′	3°00′
.41	.406	4°58′	4°51′	4°38′	4°34′	3°53′	3°39′	3°08′	3°02′
.44	.431	5°17′	5°09′	4°55′	4°50′	4°08′	3°53′	3°19′	3°14′
.45 auto.	.451	5°32′	5°24′	5°08′	5°04′	4°20′	4°03′	3°28′	3°23′
.45 Colt	.455	5°34′	5°26′	5°17′	5°06′	4°22′	4°05′	3°30′	3°24′

"Caliber" and What It Means

One of the principal ways of describing the sizes of guns is by the diameter of the bore in hundredths of an inch. This is called the "caliber" of the gun. Thus, a .30 caliber gun is one in which the bore of the gun has a diameter of 30 one-hundredths of an inch. After the hole of this diameter has been bored through the length of the barrel, the rifling is then put in, so that the diameter across the rifling grooves is always larger than the caliber. Thus a .30 caliber rifle has grooves which are .004″ deep so that the diameter across the rifling is .308″. The caliber of foreign guns is usually given in millimeters, as for example, a .30 caliber gun made in Europe would be called 7.63 m/m caliber.



Diagrammatic sketch to show how a revolver barrel would appear in cross-section. Left, Colt type of rifling, with six grooves, each approximately twice as wide as the lands. Right, Smith & Wesson type, with 5 grooves, each approximately the same width as the lands. The diameter of the bore, shown by dimension "B" in each sketch, is the caliber.

The mere fact, however, that a gun is called a certain caliber does not guarantee that the diameter across the lands will be that many thousandths of an inch, as there have been many changes in the general principles of gun construction in recent years and some of these changes have resulted in changing the diameter of the gun without changing the name of the caliber. Thus, the .38 Special Revolver of Colt make has a bore which is only .346 and grooves which are .353 in diameter. The bullet for this gun is made .359 so that .36 caliber would be closer than .38 as a descriptive name for this gun.

On the other hand, another .38 caliber revolver, the .38-40, has a groove diameter of .401 so that this should really be called .40 caliber.

Shotguns are usually named in another way, that is, by "gauge." Thus we have 10-Gauge, 12-Gauge, 16-Gauge and 20-Gauge shotguns. "Gauge" means the number of round lead balls originally fitting that gun that it took to make a pound; thus a shotgun which was the right size to shoot a one-ounce round ball was a 16-gauge gun because it took 16 of the balls to make a pound.

However, some shotguns are named by caliber, as for example the one that is called the .410 Gauge shotgun. In this case .410 gauge actually means .41 caliber.

This business of caliber names has quite a terminology of its own, which is likely to become confusing to those not in the habit of using them regularly. The student of identification is likely to come into contact with such terms as .30-30, .45-70-500, .30 U. S. Army, .30-'06, .250-3000, .38 A.C.P., .380 A.C.P., .357 Magnum, .38/44, etc.

It is essential that he know what these terms mean, and that he should avoid such common errors as referring to the Springfield Rifle as a ".30-30." Under ordinary circumstances, such small mistakes are unimportant, but for the man who styles himself a firearms expert, they may be disastrous, for they tell those in the know that his knowledge of firearms is superficial, and in many cases the opposing attorney may be smart enough to make the fullest use of the lack of confidence that is inspired by such slips. It is even worse if one or more members of the jury happens to be a gun-crank, for it will immediately tell him that the supposed expert does not really know his subject from the ground up.

In names such as .30-30, the first figure is the caliber, and the second is the number of grains of black powder that was the original standard load of the cartridge in question. Such names are only used on cartridges which were first designed in the old black powder days; they have no significance with cartridges loaded with smokeless powder. The .30-30 was originally intended to carry a charge of 30 grains of black powder. At the present time, this cartridge is loaded with smokeless powder, and the weight of the charge depends on the type of smokeless powder being used by the maker of the cartridge. The weight of charge is determined afresh by velocity and pressure firings each time that a new lot of powder is to be used. Thus the name .30-30, and such other names as were originated in the same way are really out of date, but they were learned and became familiar in the old black powder days, and no doubt will be used for a long time to come.

Names of this kind with three figures, such as .45-70-500, originated in the same way, and the first two figures mean the same thing, but the third figure is the weight of the bullet. Thus the .45-70-500 is a .45 caliber cartridge, originally loaded with 70 grains of black powder, and with a 500 grain bullet. The old black powder cartridges named in this way had plain lead bullets, or lead bullets with a paper patch, for the metal jacketed bullet came in with smokeless powder.

The old Krag Jorgensen rifle, used by the Army at the period of the Spanish-American War, and for several years thereafter, used a .30 caliber cartridge that was called the .30-40 Krag, or the .30 U. S. Army. When the .30 caliber Springfield rifle came in, in 1903, the cartridge for it was named the .30 U. S. Government. In 1906 an improved bullet was adopted, with a sharp or "Spitzer" point, instead of the original round nose. This was called the .30 Gov't Model of 1906, or more commonly, the .30-'06. After the World War, another improvement in bullets was made, and the boat-tail or streamline bullet was adopted, and the name became .30 M1. In this case, the M stands for "Mark." For many years the British have designated the successive changes of models of guns as Mark I, Mark II, etc., and our Navy has followed the same system. In the Army, this is shortened to simply M. There are some who will contend that the M stands for "modification," but it can just as well stand for either, and this point will not be argued here. In any event it will serve its purpose better than the marks used by the old woman who labelled one set of pies "T M" for 'Tis Mince, and the other set "T M" for 'Taint Mince.

All of the .30 caliber cartridges mentioned in the last paragraph are larger and more powerful than the .30-30, with which they are often confused by those with only a superficial knowledge of firearms. Moreover, they are distinctly different, and would never be confused with the .30-30 by anyone who had used both cartridges.

The British generally name their calibers by thousandths, instead of by hundredths of an inch, and many American cartridges have followed this practice in recent years. For example, there is the .276 military cartridge designed by J. D. Pedersen for the Government in 1923, and used experimentally for a time. Another example is the well known .250-3000 cartridge, in which the second figure indicates the muzzle velocity. This is a .25 caliber rifle cartridge with a standard muzzle velocity of 3000 feet per second.

Sometimes this designation in thousandths is used to designate a cartridge which is the same caliber as some other, but differs in power or in the size of the cartridge case, or some other way. For example, there is a very powerful .38 caliber pistol cartridge, called the .38 Automatic Colt Pistol Cartridge, or simply the .38 A.C.P., and there is a very similar cartridge, with a bullet of the same diameter, but with a shorter cartridge case and a less powerful load, which is called the .380 A.C.P. Again, there is a new cartridge just now being designed by Major Douglas B. Wesson, which has a bullet the same diameter as the one used in the .38 Special, and a case the same in all dimensions except the length, which is 1/10 inch greater. This new cartridge is called the .357 Magnum to distinguish it from the old cartridge of the same caliber, the .38 Special. At first glance, this may seem wrong, because the bullet diameters as indicated by the caliber names do not agree, whereas the bullets are actually of the same diameter; but actually, the new name is the more nearly correct one in this respect, for the groove diameter of the .38 Special gun is only .357, and the bullet diameter is .359 inch.

Still another kind of caliber designation is one in which two figures are used, and the second one refers to the size of the frame on which a gun of smaller caliber is built. For example, some years ago Smith & Wesson took their standard .32 caliber revolver frame, and fitted it with a .22 caliber cylinder and barrel, so that this was a .22 caliber gun which was much larger than the ordinary .22 of that day. This they called the .22/32 Heavy

Frame target revolver. As it used the ordinary .22 caliber cartridges, this name was not given to any cartridge.

On the other hand, when the same firm built a .38 caliber revolver on the frame of the .44 revolver, they called it the .38/44 Revolver, and then they proceeded to have the .38 Special cartridge made up in a high velocity type, especially suited to use in this heavy and strong gun, and this cartridge received the same name as the gun, namely, the .38/44 S. & W. Special.

This brings up the point that some of the caliber designations that we have been discussing above refer to the cartridge only, and others refer to the gun only, and some to both. Examples of names referring to guns only are, the .45 Caliber Thompson Submachine Gun; the .30 caliber Browning Automatic Rifle; the .30 caliber Springfield. Examples of names referring to cartridges only are, the .45-70-500 cartridge; the .38 Special Mid-range; the .22 Hi-Speed, the .30 caliber '06, etc. Examples of names which may apply equally well to either the cartridge or the gun that shoots it are, .22 Long Rifle, .45 Colt and .45 Automatic Colt Pistol.

Star Gauges

The bore of the gun, which gives it its caliber name, as described above, is reamed to a very exact dimension, and in order to check this diameter, the manufacturer makes use of an instrument called a star-gauge. This is a rod carrying on one end a set of guides to fit the rifling, so that the rod will follow the twist of the lands and grooves when it is pushed through the bore. The rod also carries a pair of points on opposite sides, so arranged that when a wedge inside the hollow rod is pushed in, the points will move outward. The outward motion of these points is read on a micrometer or vernier scale in ten-thousandths of an inch, so that by pushing this rod through the bore, and stopping at intervals and pushing the points outward until they touch the opposite walls of the bore, the diameter of the bore at the points in question may be read. Two sets of points are furnished, one to use when measuring the lands, and another to use in the grooves. A "star gauged" rifle is merely one which has been measured in this way to see whether or not its bore is accurately manufactured. Star gauges must be made carefully for the exact caliber of the gun in which they are to be used, and with separate heads for each type of rifling. They are very expensive, and as a rule are found only in the large arms factories.

Smoothbore Shotguns

As was intimated previously, all small arms may be divided into two general classes, namely, smooth bored guns and rifled arms. The only smoothbore that is much used at present is the shotgun, which is intended to fire a charge of small shot, and is used principally for bird shooting. A charge of shot may consist of any number of balls from 9, used in the 00 buckshot loads, to several hundred, in the loads of fine birdshot.

When the shotgun is fired, the charge leaves the barrel in a compact mass of separate pellets of shot, travelling together, but the mass immediately separates into a small cloud of individual projectiles, travelling in the same general direction, and at the same approximate speed. As the charge gets further away from the gun, the diameter of the pattern increases, so that in shooting at a bird, a hit is likely to be scored by one or more of the pellets on the edge of the pattern, even if the aim is not exact.

For shooting at land birds, where the range is likely to be short, guns are used which have the barrel bored to the same diameter at the muzzle as at the breech. These are called cylinder bores. These make the shot spread out quickly, which is desirable in shooting at close quick-flying birds, such as the partridge, which may very well be missed entirely if the shot is in a compact mass, or if hit by such a mass of shot, would be unduly torn and mangled.

For long range work, such as duck and goose shooting, it is necessary to have the pattern hold together, so that when it reaches a distance of perhaps fifty yards, where the game may be, it will not be in such a thin pattern as to be ineffective. This is accomplished by making the barrel of the gun smaller at the muzzle, so that the charge of shot is squeezed together before it leaves the muzzle. Such guns are said to be "choke bored."

While shotguns are primarily intended for the use of small shot, they can be used to fire a single large ball, and round ball loads are available commercially. However, the accuracy is very poor, for these balls have to be made with due regard for the fact that they may be used in any kind of gun by the uninstructed purchaser, and for that reason the ball is always made small enough so that it can be used in a choke bored gun. This means that for example, the ball loaded into a 12 gauge shotgun shell cannot be the full 12 gauge diameter, for the choked bore is smaller than this. On this account, the ball loaded into the 12 gauge shell would really be a much smaller size.

In addition to the round ball, there are available several types of patented conical bullet for the shotgun. These bullets have spiral ribs on the outside, or there is some other device for the purpose of obtaining some of the ballistic advantages of the rifled arm. With either the round ball or the conical bullet, the shotgun makes a deadly weapon at any range where a hit can be secured, but the effective range is usually limited by the poor accuracy obtainable.

Another odd foreign arm which is seldom seen in America is the "Paradox" gun, which is really a shotgun having the last few inches of the muzzle rifled, so that it will impart a spin to the patented slug that is used with it when it is desired to fire a large single projectile instead of a charge of shot. This gun is not very likely to be encountered in this country, but should be looked for in case the investigator finds a large shotgun projectile showing the marks of rifling.

A somewhat similar effect is sometimes secured by cutting through the paper of the shell between the wads separating the powder and the shot, so that the part containing the shot is almost entirely cut off from the part containing the powder. When the shell is fired, the forward part goes out of the gun in one compact mass. This procedure is not to be recommended, as it has a tendency to raise the pressure of the powder, for the barrel of a shotgun is smaller than the chamber that fits the cartridge, and therefore the cartridge, or shell, as it is often called, is larger than the inside diameter of the barrel. When the partly cut shell is fired, the forward part, carrying the shot load, is forced through the slope, or lead, connecting the chamber with the barrel, and as this forward part of the shell is larger in diameter than the barrel, a squeeze occurs at this point which may raise the pressure dangerously. Another squeeze occurs when this section of the shell passes the choke at the muzzle.

Besides the bird shot loads and the round ball loads, shot guns can be used with buckshot cartridges. These cartridges are regularly furnished for riot work, prison guards, etc., and the Army also uses these riot loads. The most common riot load consists of nine pellets of 00 Buck Shot which are .32 inch in diameter. Another common load is twelve pellets of 0 Buck .30 inch in diameter. Such loads are generally fired in "riot guns" which are shot guns with short barrels, cylinder bored. The riot gun is generally made in the pump action repeater type.

With the plain bird shot load, the shot gun produces terrible wounds when fired at close range, for the shot sticks together in a fairly compact mass and simply blows a "rat hole" through the victim. Within a few inches of the muzzle of the gun the entrance wound is less than an inch in diameter, but as the distance increases, the size of the hole becomes larger owing to the spread of the shot. Within a yard or so it is impossible to tell by looking at the hole whether the charge was fired by a choke bored gun or by a cylinder gun. As the range increases the pattern becomes larger until at forty yards with a choke bored gun only about seventy percent of the pellets will be found in a thirty inch circle.

Pistol Cartridge Adapters for Rifles

It is well for the firearms identification man to remember the fact that there are several makes of auxiliary chamber, or adapter, that can be used in rifles to enable pistol or revolver cartridges to be fired in the rifle. A well known adapter of this type is the one made by The Marble Arms & Mfg. Company, and called by them Auxiliary Cartridges. With these auxiliary cartridges the following pistol cartridges can be fired in rifles as listed:

.22 Caliber Long Rifle Cartridge can be used in .22 High Power Rifle.

.25 Automatic Pistol Cartridge in	.25 Short Stevens Rim Fire .25-35 Rifle .25 Remington Rifle .250-3000 Savage Rifle 6.5 MM. Mannlicher Schoenauer
.32 Short Colt Cartridge in	.30-30 Rifle .30 Remington Rifle
.32 Smith & Wesson Cartridge in	.30-40 Krag .30 U. S. Government .303 Savage .303 British
.32 Colt Automatic Cartridge in	.30-40 Krag .30 U. S. Government .300 Savage .303 Savage .303 British .32 Winchester Special
.380 Automatic Pistol Cartridge in	.35 Remington .35 Winchester
.35 Smith & Wesson Automatic in	8 MM. Rifles

The Winchester Repeating Arms Company manufactures a supplemental chamber enabling the .32 Smith & Wesson cartridge to be used in .30 caliber and .303 rifles.

The adapters described above are used in rifles, but there is a similar device for use in shotguns, called the "Rifled Bullet Shell," which renders it possible to shoot certain pistol cartridges in shotguns. These come in the more popular gauges, and are more or less used in England, but in this country they are seldom seen; in fact, the author cannot recall ever having seen one in the hands of a shooter.

The Pedersen Device

During the world war the U. S. Government adopted and kept highly secret an automatic bolt for the Springfield rifle, called the "Pedersen Device." The official name given to this device by the Ordnance Department was *The .30 Caliber Automatic Pistol, Model of 1918*. The device carries on its front end a supplemental chamber to fit into the chamber of the Springfield Rifle, and fires a special .30 caliber high velocity rimless pistol type cartridge. In use the ordinary bolt of the rifle is removed, and this automatic bolt is inserted in its place. Then a magazine containing forty rounds of the pistol ammunition is attached to the side of the device, and the first loading motion is made by hand, after which one shot will be fired for each pull of the trigger, as long as the ammunition holds out. When the magazine is exhausted a new one can be attached in a fraction of a second. The rifle with which the device is to be used is the ordinary Springfield rifle with a special ejection port cut into the left side of the receiver, and an extra lever added on to the sear. These changes in no way interfered with the use of the regular rifle ammunition in the gun, which, modified in this manner, was called the .30 Caliber Springfield Rifle Mark I. The auxiliary chamber used in this device was finely rifled with 10 lands and grooves. A bullet fired in this first received the rifling marks from the device itself then received rifling marks from the rifle barrel through which it subsequently passed. As this device was most successfully kept secret during the war and for many years afterward, any bullet fired from it would have presented a puzzling appearance to the firearms expert.

During the war about 63,000 of these devices together with 69,000,000 rounds of ammunition for them were manufactured. All this material was kept in Army stores for a good many years after the war, but finally the ammunition deteriorated and the devices themselves became obsolete and they were converted into scrap iron. Of course these devices could have been sold but it was the policy of the Government not to allow them to fall into the hands of the public where they might be put to improper purposes so they were all destroyed and not even a sample can be obtained at this time. However the device is mentioned here because it is quite possible that some of the bullets fired from this device long ago might be submitted to the expert with the question as to what it could be; and moreover there is always a chance that some of these devices may have escaped destruction and may still be in existence.

Air Guns

In detective fiction the reader will sometimes be regaled with stories of the cunning criminal who uses an air-gun of high power and mysterious design to kill his victims quickly and noiselessly. While no such weapon exists, there really are air rifles which are sufficiently dangerous to be serious candidates for the attention of the firearms expert, especially in civil suits for damages involving loss of eyesight, or some other injury.

There really have been very large air guns, which were intended for use in actual warfare. Such were the three cannon used in the 90's on the U. S. "Dynamite Cruiser" Vesuvius. This ship was intended to fire projectiles charged with dynamite, and as the shock of firing such shell from a cannon would cause a premature explosion of the bursting charge, three very large air guns were constructed and installed in the forward part of the ship. They were built into the structure of the vessel, and projected at a considerable angle of elevation from the forward deck. This ship was used, with small effect, in the bombardment of Morro Castle at Santiago De Cuba in 1898. The air pressure was sufficient to throw the projectiles a mile or more, but not with any great speed. They were not intended to penetrate, but rather to have a blasting effect by the explosion of a large quantity of high explosive against the surface.

At the present time, there are a number of air rifles made to shoot a small spool shaped pellet of .22 or of .177 caliber, with a velocity of about 435 f.s., as described on page 12 of the TEXTBOOK OF PISTOLS & REVOLVERS. The .22 caliber pellet weighs 15 grains, and thus will give a muzzle energy of 6.3 foot pounds, which is about ⅛ of that given by the least powerful common firearm, the .22 short rim fire rifle. These little bullets will penetrate about one-half inch in ordinary soft pine wood, and will readily kill birds and small animals. In one case known to the author, a pig was killed by a B.S.A. Air rifle. The bullet struck in the abdomen, and penetrated far enough inside to cause the animal to be found dead a day or two later.

While ordinarily these guns would not be classed as deadly weapons, it is certain that if a person were shot in the abdomen with such a gun, death might follow if proper surgical attention were not promptly given; and it is self-evident that such guns are capable of destroying the eyesight. Owing to the very light weight of the bullets used, and their blunt shape, they lose velocity very rapidly, and would hardly do any appreciable damage at a range greater than 100 yards.

Perhaps the best known gun of this type is that made in England by the Birmingham Small Arms Company, which is called the B.S.A. There is one made in the United States, which is called the Crosman. The B.S.A. has 12 lands and grooves, left handed twist, while the Crosman has six lands and grooves, right hand twist. Another gun of this kind, which is quite powerful is the Webley, and there are several different ones made in Germany, and sold under different names.

CHAPTER 3

ELEMENTARY PRINCIPLES OF AMMUNITION

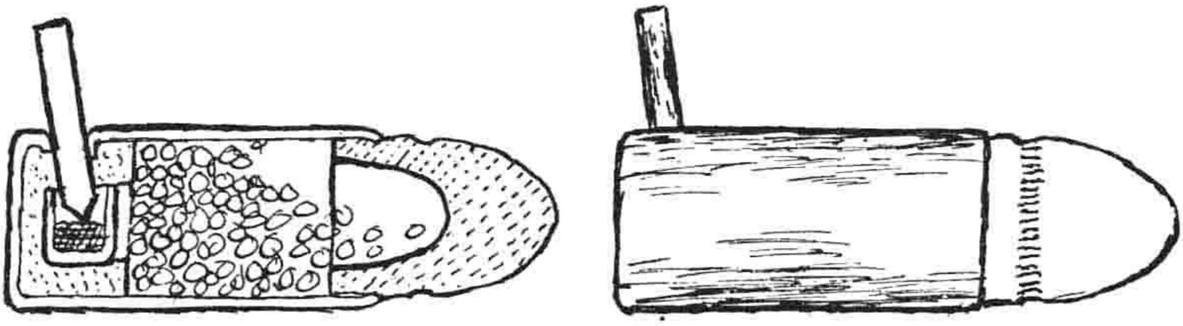
THE earlier guns were muzzle loaders, which were loaded by first putting a charge of powder into the barrel, then putting in a bullet and forcing it down on top of the powder with a ram rod, and then priming the gun. In the earliest muzzle loaders, this priming was accomplished by putting a charge of very fine powder in a "pan" on the side of the breech, which communicated with the interior of the barrel by means of a small hole. When it was desired to fire the gun, the priming charge was ignited by means of a slow match; or in later years, by the sparks from a piece of flint held in the "cock" which corresponds to the hammer of a modern gun.

A great improvement was the invention of the percussion cap. This is a small copper cup containing some material which will ignite when it is struck or crushed. In the later muzzle loaders, a hollow tube or "nipple" projects from the breech, and the hole in the nipple communicates with the charge inside. To fire the loaded gun, the hammer is cocked, a cap is placed on the nipple, and the trigger is pulled, which allows the hammer to fall and explode the cap. The fire from the cap flashes through the hole in the nipple and ignites the charge. When the cap explodes, it generally splits to pieces, and part of the flash surrounds the outside of the nipple, making a gray smudge on the nearby metal. In a day or two this gray smudge becomes streaked with bright red rust. By looking at this point on a muzzle loader, it can be quickly told if the gun has recently been fired. Some muzzle loaders are still in use throughout the country. Perhaps the double barreled shotgun is the type most often seen in use today.

The muzzle loading muskets or rifles were often supplied with cartridges, which consisted of a bullet having a paper packet attached to it containing the proper amount of powder to make up a charge. To load, the end of the paper was torn off and the powder poured down the barrel, then the bullet was rammed down on top of it.

Cartridges for Breech Loaders

When the breech loader was in the process of invention and development, the greatest difficulty that was encountered was the tendency for the gas of the explosion, under its terrifically high pressure, to escape through the joints of the mechanism. The breech loader was never successful until a way was found to overcome this difficulty. The way finally devised was to use a metallic cartridge to hold the powder and to close up all the joints and cracks in the breech. The cartridge is always made of soft metal, such as copper or brass, which expands from the effect of the internal pressure, and hugs the walls of the chamber so tightly that no gas can escape past it except from the front end, and it covers up the cracks at the rear so that no gas can get through in that direction.



Lefaucheaux Pin-fire cartridge. Sketch from a sample in the author's collection. A percussion cap, like the ones used in the old cap and ball revolvers, is held in a fiber holder inside the end of the cartridge. Each cartridge contains its own firing pin, as shown, which projects through a slot in the breech of the barrel or cylinder, so as to be struck by the hammer in falling.

Different Kinds of Cartridges

The first type of metallic cartridge to become popular was what is known as the pin-fire type. Cartridges of this kind have a primer or cap inside and a little pin like a short nail sticking out of the side. There is a slot in the breech of the gun barrel or revolver cylinder for this pin to stick through, and in firing the gun, the hammer drives the pin downward into the cartridge, discharging the cap. Pin-fire cartridges are still used occasionally in many foreign guns, but are comparatively rare in America.

The next type to be invented was the rim-fire cartridge, first produced in .22 short caliber by Smith & Wesson in 1854. This is still enormously popular today, and is constantly coming to attention in shooting cases. The rim-fire cartridge is simply a short tube of copper, closed at one end, having a charge of powder in it, and carrying a bullet in the open end. The closed end is formed into a flat head, with a hollow rim, and inside this rim there is a layer of percussion priming mixture. When the gun is fired, the firing pin, or the hammer nose, as the case may be, strikes this hollow rim, and mashes a small portion of it, crushing the mixture at this point, and causing it to ignite and fire the charge.

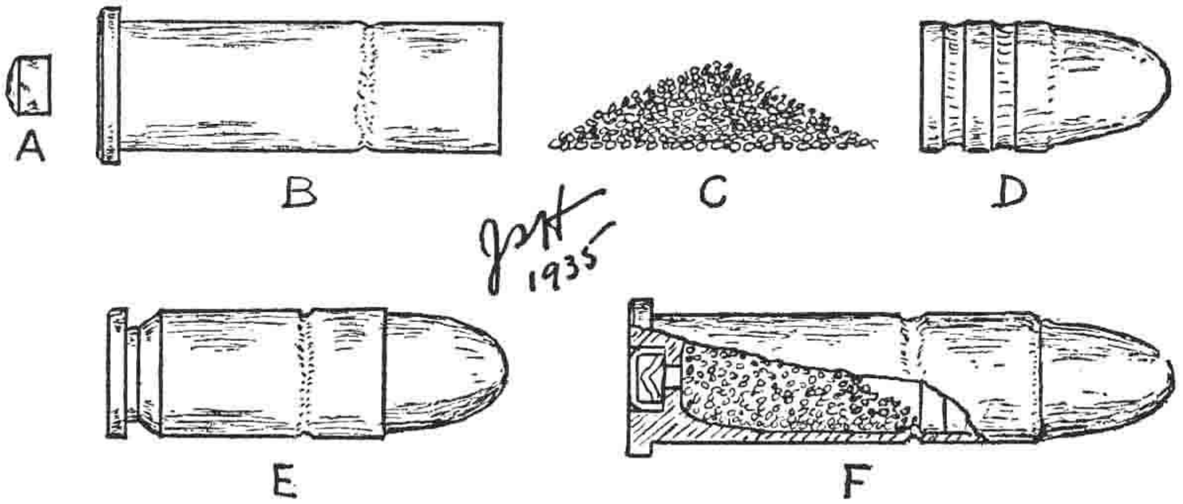
The copper of which the rim-fire cartridges are made is soft and thin, therefore it swells out under the pressure of the explosion, and takes a good impression of all depressions in the chamber, such as the parts cut away for the extractor. It also takes a good impression showing the shape of the firing pin, but it does not often take a clear impression of the fine file marks and other irregular scratches on the breech block, which form the "finger-prints" of the gun; hence when an empty rim-fire cartridge is found at the scene of a shooting, it is often easy to say what type of arm was used; but it is seldom possible to identify a rim-fire cartridge to a definite individual gun by the impression of the file marks it left on the head, as is so often done in the case of a center-fire cartridge.

The .22 caliber rim-fire cartridge is the most popular of all cartridges made today, and enormous numbers of them are used in rifles, single shot pistols, automatic pistols and revolvers. Besides the popular .22 short, .22 long, and .22 long rifle cartridges, there are several other kinds of .22 made and sold, such as, for example, the somewhat larger kind known as the .22 W.R.F. (Winchester Rim Fire); the special inside lubricated .22's made for use in the .22 Winchester Automatic Rifle and the .22 Remington Autoloading Rifle; and the very small .22's known as the .22 BB Cap (Bullet Breech Cap), and the .22 CB Cap, (Conical Ball Cap) that can be used in any arm chambered for the .22 short, long, or long rifle.

Another rim-fire cartridge that is still used to a certain extent, and for which an arm is still made, is the .41 short, used in the deadly little Deringer pistols. The Remington Arms Company still make the .41 double Deringer. Years ago, rifles and revolvers using the .32 and .38 caliber rim-fire cartridges were popular. These guns are no longer made, but the cartridges can still be purchased. Then there are .25 caliber and .41 caliber rim-fire rifle cartridges that are still made and sold. The student should become familiar with all of these cartridges.

Center-Fire Cartridges

While the rim-fire cartridge still enjoys enormous popularity in the .22 caliber, it has been superseded in practically every other caliber by the later type known as the center-fire cartridge. This is a brass cartridge with a thick, heavy head, containing a percussion cap, or *primer,* pressed into a circular recess in the center. A flash hole in the center of the primer pocket communicates with the powder space inside. The cartridge is filled with powder, and carries a bullet in its open end.



1935

COMPONENT PARTS OF LOADED CARTRIDGE.

A. Primer or "Cap." B. Case or "Shell." C. Powder or "Charge." D. Bullet, Projectile or "Ball." F. The assembled Cartridge, a Round of Fixed Ammunition or a "Load"; the .38 S. & W. Special, a rimmed type of cartridge. E. A rimless type of cartridge loaded with a metal-cased bullet held friction tight by the neck of the case. F illustrates a lead bullet held in place by crimping over the mouth of the case. Both cartridges are loaded with smokeless powder and the cases are cannelured to prevent the bullet from slipping down on the powder.

These cartridges are made by punching discs from a sheet of brass, and then drawing these discs out into tubes, closed at one end. When brass is heated it becomes very soft and ductile, and very weak; when it is drawn, or otherwise worked, it becomes hard, strong, and elastic. The heating of brass to make it soft, so that it can be worked with ease is called "annealing."

When cartridges are to be used with high pressure loads, the walls of the case, near the head, must be quite thick and strong, because the chamber is often cut away at the back for the extractor, or is tapered to make the cartridges feed easily in repeating arms; and at this cut away portion all that lies between the outside world and the high powder pressure inside when the gun is fired is the wall of the case, which bridges the gap. If it is made too weak or soft, it will blow out and allow the gas to escape, with possible disastrous consequences. Moreover, the head of the case, which rests on the breech block of the arm, must also be made hard and strong, to prevent it from expanding and allowing the primer pocket to enlarge and permit the escape of gas. On the other hand, the primer, which is made of brass or copper, must be quite soft to allow the firing pin to dent it in, and thus crush the percussion mixture inside.

When the cartridge is fired, the entire gas pressure acts on the inside of the cartridge head to force it back against the face of the breech, and the soft metal of the primer usually takes a good impression of the fine scratches, tool marks, or file marks on the face of the breech. The head of the cartridge itself also very often takes good imprints of these marks, but it does not do this as readily as does the primer, because it is made of harder material, as was explained above. If the chamber of the gun is oily, so that the cartridge can slip back to the rear easily, the pressure of the cartridge head on the breech block is increased, and the marks are more pronounced. Copper primers take a better impression than do the harder brass ones. There is a big variation in makes and types of ammunition in this respect. Sometimes very abundant prints, which are excellent for identification, are obtained; at other times, the prints obtained on the primer or the head of the case may be very few or none at all, and identification by this means may fail entirely.

The Berdan Primer

There is a difference in the internal construction of the primer and cartridge case between the American and the European standard practice of manufacture, which may at times aid the expert in determining the origin of the cartridge. This difference is in the anvil of the primer, and the flash hole or holes leading from the primer pocket through the head of the cartridge.

When the firing pin strikes the primer, it dents the metal in, and the object of this denting is to crush the priming composition against another metallic surface situated inside the primer, called the "anvil." In American practice, this anvil is a separate little piece of brass, inside the primer, while in the European manufacture, the anvil is a little point sticking out in the bottom of the primer cup, formed from the metal of the cartridge case itself. In American practice, there is only one flash hole, and this is in the center of the primer cup; but in the European practice, the center of the primer cup is occupied by the anvil, and there are two or three flash holes, to the sides of the center. The American type of primer is called the "separate anvil" type, while the European is called the Berdan type, after the American inventor, Colonel Berdan. See illustration on page 277 in Textbook of Pistols and Revolvers.

By looking into the fired cartridge case, it can readily be determined whether or not it is of American make, for if it has but one flash hole, and that in the center, it is of the American type; while if it has two (or more) flash holes, one on each side of the center, it is of the Berdan type. This can, of course, also be determined by removing the primer. To remove the primer of an American type cartridge, a small punch is inserted through the flash hole, and the primer is driven out, while to remove a Berdan primer, the case is filled full of water, and a bullet or other tightly fitting plug is inserted into the front end of the case, and then supporting the head of the case on each side, so the primer is unsupported, the bullet or plug is struck a sharp blow with a hammer, when the pressure of the water will force the primer out of its seating. But the investigator will not want to remove the primer of an "evidence" cartridge case, for such evidence exhibits must not be changed.

It will be well for the reader to realize that while the present practice is for the Berdan Primer to be made and used only in foreign ammunition, there are a few exceptions that have occurred in the past. The Berdan Primer was invented in the United States, and was used here in some of the early cartridges, but was superceded by the separate anvil type some forty or more years ago. However, during the World War, at least one of the American cartridge companies which made military ammunition on contract for foreign governments used the Berdan Primer. Then in 1930, the Government arsenal at Frankford made a few Berdan type .30 caliber rifle cartridges for the National Matches, in connection with experiments made on non-corrosive priming.

Rim, Rimless and Semi-Rim Cartridges

When the cartridge is put into the gun, there must be something to stop it from going all the way into the gun barrel, and to support it against the firing pin blow; and there must also be something for the extractor to hook on to to pull the empty case out of the gun after it is fired. Most cartridges are made with a *rim* around the head, and this rim fulfills both the functions mentioned above. However, a raised rim of this kind interferes with the loading of cartridges from a box magazine, such as is used in automatic pistols and in military repeating rifles, and cartridges intended for use in these arms are often made without a raised rim. Instead, they have a groove cut around the head for the extractor to hook into. These cartridges are said to be of the "rimless" type. The .30 caliber U. S. Government cartridge, used in the Springfield rifle is rimless. It is a "bottle-necked" cartridge, which has a body that is larger than the bullet, and the slope or "shoulder" where the neck of the cartridge joins the body, bears against a corresponding slope in the chamber, and thus forms a fixed seating for the cartridge and supports it against the blow of the firing pin. Many other high powered rifle cartridges are made in the rimless, bottle-necked type.

The .45 Automatic Pistol cartridge is also rimless, and as this is a perfectly straight cartridge with no taper or bottle neck, some different method must be used for seating it and supporting it against the firing pin blow. This is done by leaving the front edge of the case perfectly square, and seating it against a corresponding shoulder at the front end of the chamber. This means that the front edge of the cartridge case cannot be crimped onto the bullet, but must be left perfectly square, and that the bullet must be held in place in the neck of the case by friction only. See sketch on page 278, Textbook of Pistols and Revolvers.

The .25, .32, and .38 Automatic pistol cartridges, and the .32, .35, .351 and .401 Winchester Self Loading Rifle cartridges, which at first glance seem to be rimless, have no square edge to the front of the cartridge case, as the case is crimped into a groove, or cannelure around the bullet. In these cartridges the rim is made just a little bit bigger than the diameter of the case so that there is really a slight bearing of the rim against the back end of the chamber. These are not strictly rimless cartridges but are what is more properly called "semi-rim." Rimless pistol cartridges are designed primarily for use in automatics, but there are also some revolvers, such as the Colt and Smith & Wesson Model 1917 revolvers, which use the .45 automatic pistol cartridge.

Cannelure on Cartridge Case

The observant user of firearms will note that many pistol cartridges have a groove, or cannelure, around the case just back of the bullet. This is to keep the bullet from being pushed all the way in onto the powder. Usually, this cannelure is not seen on cartridges loaded with black powder, for two reasons. First, the charge of black powder fills, or nearly fills, the powder space, and so the bullet cannot go too far in, because it is stopped when its base comes against the powder charge; and second, it makes no difference in the burning of the powder if the bullet does rest on or compress the charge. Thus in the days of black powder, no cartridge cases had cannelures. But when smokeless powder came in, two new conditions arose. First, smokeless powder is much more concentrated, so that it only partly filled the powder space; and second, it is very sensitive to changes in powder space, or to compression. Under these conditions, some method of limiting the backward motion of the bullet had to be provided, and the cannelure was devised for this purpose.

There is, of course, nothing to prevent the use of a cannelured case for both black and smokeless loads; but many makers still put their black powder loads in plain uncannelured cases, as an aid in identifying the two kinds and keeping them separated in the factory.

Some years ago there was another way of telling a black powder cartridge from one loaded with smokeless; that was the difference in the appearance of the primer. Smokeless powder requires a stronger primer than that necessary for black powder, and when smokeless powder first became popular, special primers were used for smokeless loads, and these smokeless powder primers were often marked with an initial or monogram of the maker. This practice has now been discontinued, as all primers now made are intended for use with smokeless powder, and are also used when the cartridge is loaded with black powder.

Corrosive and Non-Corrosive Primers

In recent years there has been a change in the general practice of primer construction that is of importance to the firearms identification expert, for it entirely changes what had previously been the rule for judging how long it had been since an arm was fired. The change referred to is the almost universal adoption in America of non-corrosive primers, which were first introduced into this country in the .22 caliber rim fire, though they had already been known and used in Europe for sometime previously.

Before this change, it was necessary to clean a gun promptly and thoroughly after firing, if serious rusting and corrosion was to be avoided. It was definitely determined that the cause of this trouble lay entirely in a certain product of the combustion of the primer, and by suitable changes, the deleterious salt was eliminated, and with present day smokeless powder, a gun which has been fired can lie for weeks without cleaning, and during this time there will be no changes that will serve to tell how long ago it was fired.

Bullets

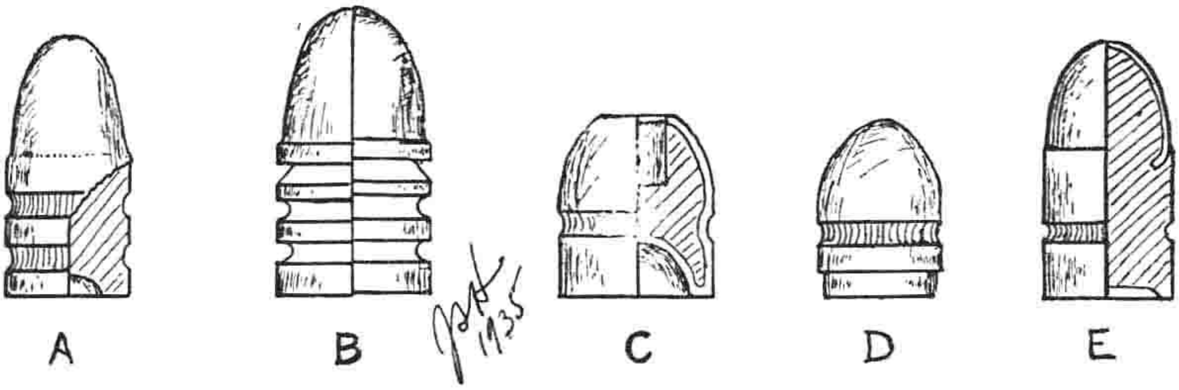
In the old black powder days, all bullets were made of plain lead, or of lead hardened and strengthened slightly by the addition of a small percentage of tin, or of antimony, or both. This hardening helps to keep the bullet from "stripping," or jumping the rifling, and also helps to reduce the tendency for the lead to adhere to the barrel in patches, a trouble that is known as "leading."

Low-power rifle bullets, including the .22 caliber ones, and most revolver bullets are still made in this way. They are usually lubricated with a grease, or lubricating compound, for unless this is done, there will be very bad leading of the barrel. Some lead bullets are plated with cadmium instead of being lubricated, and this helps to prevent leading, but will not prevent it altogether if a series of shots are fired rapidly, as from an automatic pistol such as the Colt Woodsman. In some companies in an effort to further reduce the tendency to lead, the bullets are plated with a very thin coating of copper; or of a compound known by the trade name of Lubaloy, (Lubricating Alloy), which really is mostly copper, with a very small percentage of tin and zinc added. The copper plated or lubaloy plated bullets are usually lubricated.

The lubrication is placed in "cannelures" or grooves around the bullet. The earliest bullets were made with a reduced portion, or heel, which fits into the neck of the cartridge case, and the portion of the bullet forward of the heel is of the same diameter as the outside of the cartridge case. This forward portion of the bullet is provided with one or more grooves which are filled with lubricant; or in some cases, there is no groove at all, and the forward portion of the bullet is lubricated by simply being dipped into melted grease. Cartridges of this kind are said to be "outside lubricated," and are messy and sticky to handle. A number of the cartridges which were originated many years ago, and consequently were designed in this way, are still made with the outside lubricant. Examples are the .22 short, long, and long rifle, the .38 Short Colt, the .41 Short, and others.

The cartridges of more modern origin are designed in what is known as the "inside lubricated" type. In these, the bullet has no heel of reduced diameter to fit the cartridge case; instead, the body of the bullet forward of the case is the same diameter as the part inside, and the case is therefore larger than the bullet. The grooves for the lubricant are in the part of the bullet that is inside the cartridge case, and therefore the grease is all covered by the sidewalls of the cartridge case, the exposed part of the bullet is free from grease, and the cartridges are clean to handle.

When a lead bullet is fired, the soft metal expands sideways under the impact of the pressure on its base, and fills every available bit of space in the barrel. Thus it fills the grooves of the rifling and takes an excellent impression of the surface over which it moves in passing through the barrel. Any little elevations in the surface will plough through the soft surface, and leave a corresponding scratch; and any grooves in the surface of the barrel, especially if they are at the muzzle, will leave corresponding ridges on the bullet.



TYPICAL REVOLVER BULLETS

A—Factory swaged lead bullet for .38 S. & W. Special, round point, cupped base and two lubricating grooves; note that the latter have been rolled into the bullet by knurled rollers. B—A hand cast or "home made" bullet for the .44 S. & W. Special cartridge, the two bottom grooves are for lubricant while the top one is a crimping groove into which the mouth of the case folds. Sketch shows the line running longitudinally around center of bullet where the two halves of the mould come together and artist has illustrated the fact that the halves do not exactly meet, a fault occasionally found in an old mould. C—A metal-cased .44 40 hi-speed rifle and revolver bullet; its jacket is of copper colored gilding metal and it would be considered a copper jacketed bullet by the uninitiated. Metal cased bullets are seldom lubricated and the one groove is for crimping but its knurling also helps to fasten the jacket to the lead core and prevent "stripping." This bullet has a flat, hollow point and also a hollow base. D—An old fashioned outside lubricated, or "heel" bullet for the .38 rim-fire cartridge; the reduced diameter fits tightly into the mouth of the case and is then crimped. The bullet end of cartridge is dipped into melted lubricant which covers all exposed lead and also fills the one lubricating groove provided, making a very messy cartridge to handle and one practically obsolete in all but .22 caliber rim-fire ammunition. E—Our most modern revolver bullet, the "metal-point" .38/44 recently developed by Smith and Wesson. Entire bearing surface of rear of bullet is of lead with one lubricating groove, point is encased in cupro nickel. Base is slightly cupped.

Jacketed Bullets

With the advent of smokeless powder, higher velocities became possible, but it was soon found that the ordinary lead, or lead alloy bullets described above would not stand these velocities without stripping or jumping the rifling, or having the surface melted. This led to the introduction of what is known as the "Metal Jacketed" type of bullet, which is now standard for use in high powered rifles, and which is also almost universally used in automatic pistols, on account of the added strength it gives the bullet to stand the feeding through the magazine and mechanism.

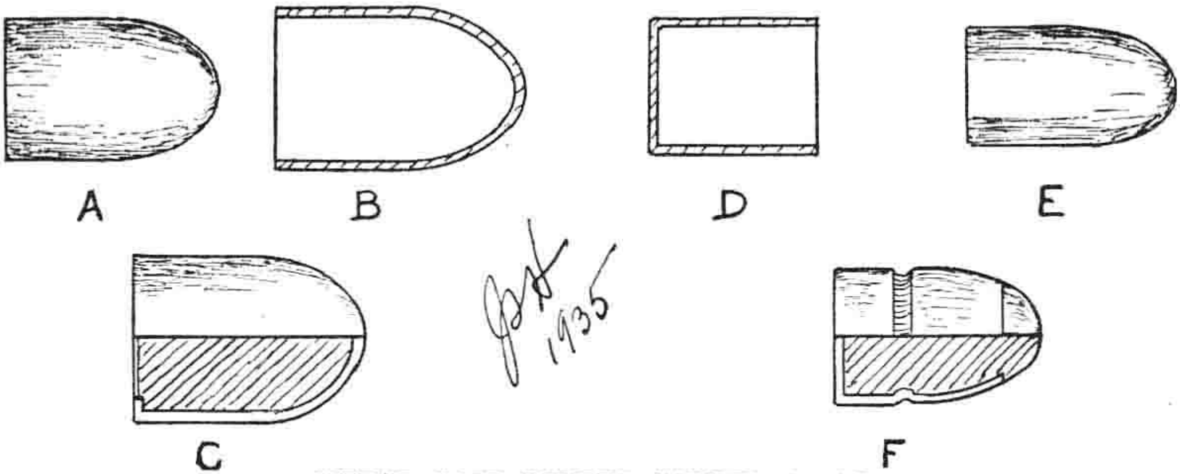
In this type of bullet, there is a hollow case, or bullet jacket, formed out of cupro-nickel, gilding metal, or soft steel, and the lead core, or main part of the bullet is placed inside this harder envelope, and the bullet is then swedged to its final shape in a heavy press, which turns over the edges of the jacket at the base of the bullet, so as to hold the core firmly in place.

There are several different types and kinds of metal jacketed bullets made. The ordinary military bullet is open at the base, and has the point covered with the jacket; but for hunting, the base is often closed, and the point left uncovered, so that the soft lead core shows. This is called a soft-point, mushroom, or Dum-Dum bullet. When it strikes a resisting object, the lead at the point expands, or "mushrooms," and the bullet thus becomes much more deadly, as it tears a larger hole. Sometimes there is a hole in the point of the bullet, which greatly facilitates the expansion on impact. A bullet with a hole in the point is called a hollow point, or "Express" bullet.

Some of these soft point bullets have the disadvantage, when they are used in rifles with a box magazine, of having the points tend to batter in the magazines, from the shock of recoil, or from other causes. For this reason, it is quite common to find various different patented constructions used to protect the point, and at the same time allow the point to expand when it strikes game. For example, there may be a small peg, or point, of copper, inserted in the very end of the soft point.

In the military ammunition, there are several special kinds found which are not ordinarily made in commercial ammunition. For example, there is the armor piercing cartridge, which has a hardened steel core inside the bullet. At short ranges, this will pierce a half inch or more of armor plate, on which an ordinary jacketed bullet would simply make a gray splash. Then there is the tracer bullet. The front part of the jacket has a short lead core in it, that does not fill the whole jacket. The bottom of the jacket is filled with a chemical composition, generally containing magnesium, barium peroxide, and barium nitrate, or some other such mixture. This is pressed into the base of the bullet under great pressure, so that it seems almost as hard as a rock. When the gun is fired, this tracer compound ignites, and burns with a brilliant flame, which is visible as the bullet flies along, and thus makes it easy to see where the shot has gone. Tracer cartridges of this kind are made in the .45 caliber automatic cartridge, for the Thompson submachine gun.

The jacketed bullets do not expand as readily under the effect of the gas pressure on the base as do the lead ones first described.



1935

METAL CASE BULLET CONSTRUCTION

The metal-cased or metal-jacketed bullet is made by enclosing a core or slug of lead alloy in an envelope of harder and stronger metal. The standard practice in America is to make the jacket of cupro-nickel, gilding metal, or Lubaloy, while in Europe the jacket is often made of steel plated with gilding metal or with cupro-nickel. The sketch shows the method of construction. A is the core of a .45 caliber automatic pistol bullet, B is the jacket, and C is the assembled bullet, made by inserting the core A in the jacket B, and then swaging the two together under heavy pressure, at the same time crimping the edges of the jacket over the base of the core as shown. In making a soft point bullet, shown at the right, the jacket is made closed at the base and open at the point, and the core is inserted from the front, and then is crimped on to the core as shown. The cannelure, or groove, around the bullet serves not only as a place into which the front of the cartridge case may be crimped, but also as a method of giving the jacket an additional hold on the core.

Ordinarily, they do not fill up the grooves completely, and often a jacketed bullet will show the marks left by the friction of the barrel only where the tops of the lands of the rifling bore, and for a small space in the center of the groove marks on the bullet. The bullet is likely to have far less of the fine identifying scratches than are left on a lead bullet, but this is counterbalanced by the fact that the marks on the surface of the lead bullet are more easily obliterated by impact with hard surfaces, by the mashing of the bullet on impact, or by rough handling during extraction from the body, while those on the jacketed bullets will persist, even when the bullet has struck some hard object.

Sometimes, when a soft-point bullet strikes an animal or other object, the jacket will open up at the point, and the lead core will leave the jacket, and be lost, while the jacket will be recovered. In such cases, the jacket will retain the barrel markings perfectly.

The reader should understand the difference between the copper or lubaloy plated lead bullets, first mentioned, and the jacketed bullets. In the plated bullets, the bullet covering is just a very thin film, perhaps one or two ten-thousandths of an inch thick, while the drawn jacket of the metal cased bullet is from 25 to 30 thousandths of an inch in thickness.

The lead bullets that have the thin plating of copper or lubaloy are much more difficult to identify than the plain lead ones, because in the plated ones, the plating breaks up into irregular flakes covering the surface, which make the comparison of the markings a particularly annoying task.

It may be stated here that the metal jacketed bullets are not lubricated, for the metal does not adhere to the barrel as easily as does the plain lead, and therefore, lubrication is not necessary. But sometimes, particularly with the cupro-nickel jacketed bullets, a portion of the metal of the jacket does adhere in patches to the inside of the barrel, most often near the muzzle. This condition is called "metal fouling," and a metal fouled barrel will tear the surface of the bullet very badly, and therefore this condition may have quite a definite bearing on the identification of the gun which fired a given bullet. For example, if a bullet is fired from a barrel which afterwards picks up metal fouling, identification may be rendered difficult; if the crime bullet is fired from a badly fouled barrel, a test bullet fired from the same barrel immediately afterward may be easier to identify. If the barrel picks up more fouling before the test bullet is fired, identification is harder, or may be impossible. If the metal fouling is removed after the evidence bullet is fired, and before the test bullet is obtained, identification may fail. When the old cupro-nickel jacketed model of 1906 bullets were being used in the army, the use of an ammonia solution to remove metal fouling was routine. Now that the service bullet is jacketed with gilding metal, metal fouling is of rare occurrence in the army rifle. But many hunting bullets are still made with cupro-nickel jackets, and the possible occurrence of metal fouling and its bearing on the question of identification should be borne in mind. Metal fouling can be recognized on visual inspection by the appearance of small raised patches inside the bore near the muzzle. The author's simple barrel telescope, described in another chapter, can be used to great advantage in looking for this condition.

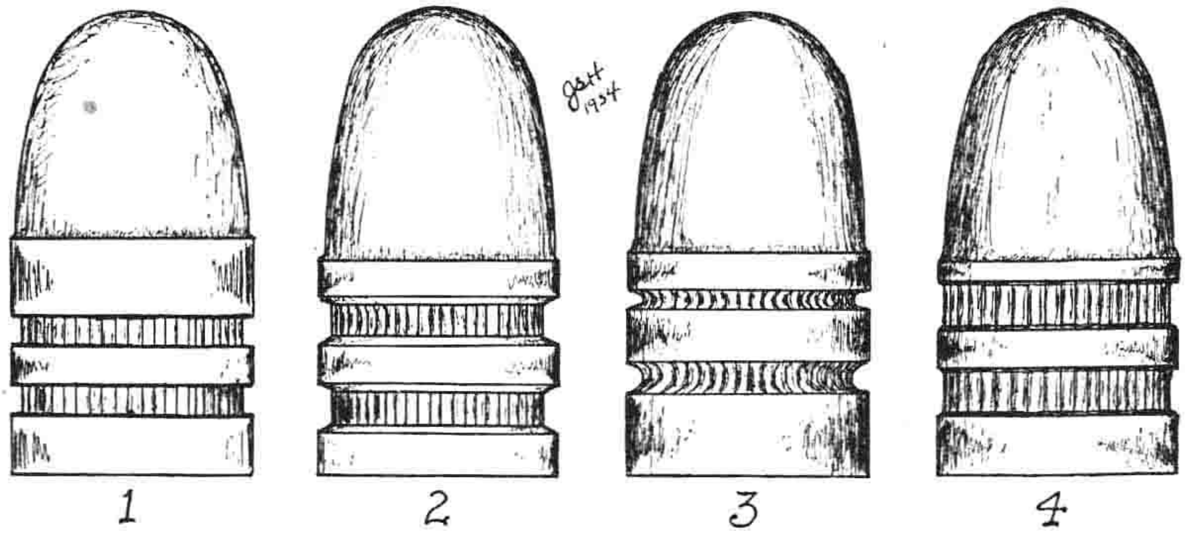
It should be noted that jacketed bullets made in America are always covered either with gilding metal, which is an alloy of approximately 90 parts copper and 10 parts zinc, or with cupro-nickel, which is 60 parts copper and 40 parts of nickel, and is a white metal looking like German silver. There is no such thing as a steel jacketed bullet made in America. On the other hand. steel either heavily coated with cupro-nickel or not coated at all is the favorite jacket material for European made ammunition. This fact in itself may sometimes be of use in clarifying circumstances surrounding a crime and pointing investigators in the right direction. Two men who might possibly have been involved in a shooting affair in which the victim was killed with a small .32 caliber bullet were each found to have in their possession a partly used box of .32 caliber cartridges. The cartridges belonging to "A" were of domestic make while those belonging to "B" were imported. The investigator applied a magnet to the fatal bullet and found that it was attracted to the magnet thereby proving that it had a steel jacket, indicating the probable innocence of "A".

It should also be remembered that bullets are rarely made of pure lead but frequently are made of a lead alloy consisting of a mixture of lead and some other metal such as tin, or antimony, or both, this material being added in order to make the bullet harder. Moreover, birdshot may contain a certain percentage of arsenic. Thus the bullet metal may furnish valuable evidence if a chemical analysis or other test is made to determine the character of the bullet material. Among the other tests which could be used instead of chemical analysis might be mentioned a test of specific gravity, as both tin and antimony are lighter than lead and the addition of these materials changes the specific gravity of the bullet.

It is mentioned in this place because every investigator should realize the possibilities of gaining information from this source and if the case seems to warrant it he can recommend that an analysis or test of this character be made.

Bullet Cannelures

The word "cannelure" is often heard in connection with ammunition; it simply means a groove of any kind around a cylindrical portion of either a cartridge case or a bullet. Most lead bullets have several cannelures, which were originally provided for the sole purpose of holding a supply of grease or lubricant, by which the bore is kept oiled to prevent the lead of the bullet from rubbing off under the intense heat and friction of the passage through the barrel. Unless the bullet is properly lubricated, or some other steps are taken to prevent it, the lead will solder itself to the surface of the barrel in lumps and patches; and once this action starts, the patch adhering to the surface will scrape off more lead from each succeeding bullet, until the barrel may actually become choked up in extreme cases. Cannelures also enable the maker to add somewhat to the length of a lead bullet, yet keep its weight to a minimum.



CANNELURES ON LEAD BULLETS
The way in which differences in the form, appearance, and location of the cannelures can assist in identifying the make of a bullet is quickly apparent from the sketch, which shows four bullets of the same caliber and of approximately the same date of manufacture, from the four leading American cartridge factories.

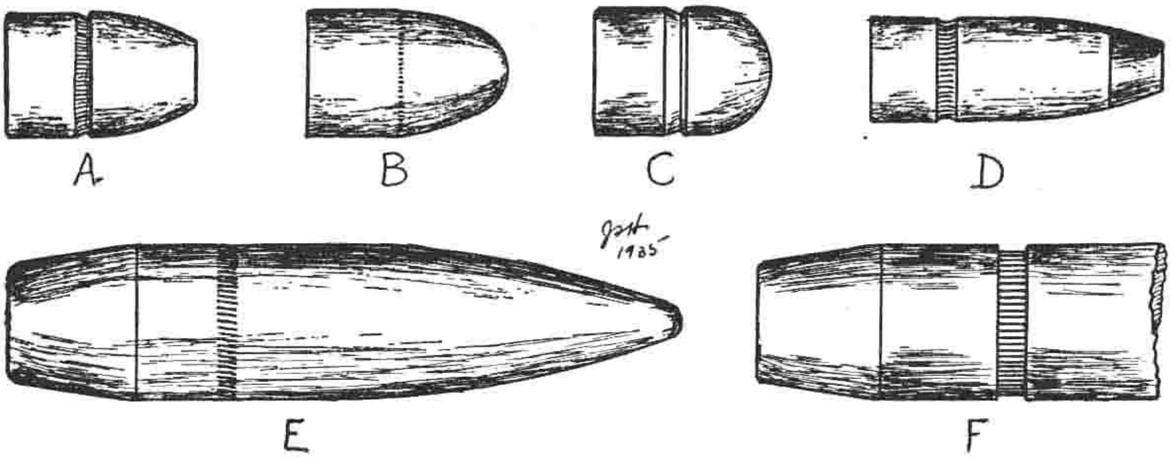
Generally lead bullets have two or more of such grooves, which differ very decidedly among the various makes and types of bullets. These grooves are rolled into the sides of the bullet by means of rotating discs with a corrugated rim, called *knurling discs,* or just knurls. The operation of putting these corrugations onto a metal surface is called knurling, and the resulting rough surface is said to be knurled. The knurling heads naturally vary in size, shape, width, and particularly in the pattern of the knurling, between the different makers. Thus one maker may roll out a square bottomed cannelure, while another makes a deep circular one, and still a third may roll a shallow oval into the sides of his bullets. Then one maker's knurling may consist of a row of closely spaced, straight lines; another's may consist of the same kind of lines spaced further apart; then slanting lines might be used, or checkering, or small dots, etc. The differences between the different makes, and even between a single maker's product of different dates will be readily noticed, and is often very distinctive.

The main trouble in identifying these cannelure markings is that the soft lead bullet may be so smashed up and distorted that there are not enough clear markings remaining to compare. But it takes only a short stretch of undistorted markings to establish a check. An examination of the cannelure markings may help the investigator in several ways, one of which, for example, is to give an indication as to whether or not the evidence bullet is of the same kind as those from a partly used box found in the possession of the suspect. While it may be a practical impossibility to trace bullets clear back to the maker by means of such markings, it is often an extremely easy matter to say by their aid whether or not cartridges in the possession of a suspect are of the same type as those from which the evidence bullet was fired.

Several years ago, a friend of the writer's who is particularly well qualified in the field of firearms investigation was unexpectedly called as a witness in a homicide trial, and hustled into the court room by the defense lawyer without a minute's notice, and much against his will was compelled to give testimony which actually acquitted the negro under trial. It appears that as soon as he got upon the witness stand and was handed the main exhibits in the case, consisting of two lead .38 S. & W. bullets taken from the murdered negro's skull, together with the remains of a box of similar unfired cartridges taken from the room of the accused, he at once saw that the bullets were of an exactly similar type, as this was indicated conclusively by the cannelure size, shape, and marking, and by the size, shape, and hardness of the bullets. But it was rendered impossible for him to explain this by the attitude of the prosecuting attorney, who was doing his best to hang the prisoner, and therefore took a hard-boiled attitude with this witness because he had been introduced by the defense. He compelled the witness to answer "yes" or "no" and came near having him fined for contempt of court when in response to certain questions he would have explained the points of similarity. By his hard-boiled attitude this district attorney lost his case, for the witness, who well knew that the bullets showed many points of similarity was not allowed to say anything about it, and the defendant was acquitted.

When it comes to metal cased bullets, there is no need of grease grooves, as full patch, or metal jacketed bullets cannot lead the barrel, and usually are not lubricated. It may be said, in passing, that they may cause metal fouling, which is the adherence to the barrel of metal rubbed off of the cupro-nickel or gilding metal jacket. Sometimes, especially with high velocity rifles, where the friction in the barrel is great, metal fouling with cupro-nickel jacketed bullets may reach very annoying proportions; but with gilding metal jackets it is much less often seen, and with low velocity weapons, like pistols and revolvers it is hardly ever heard of.

While the full jacketed or soft point bullets do not have grease grooves, they usually do have one cannelure, which is used for the purpose of crimping the bullet firmly into place in the cartridge case. In revolvers, the recoil of the gun jerks back the other unfired cartridges in the cylinder, and may thus cause the bullets to move forward in the cases enough to jam the cylinder from rotating, unless those bullets are crimped in place. In automatic pistols, the cartridges in the magazine are bumped on the nose each time the gun recoils, and if the bullets were loose in the necks of the cases, they might be driven down on top of the powder, which would raise the pressure. For these and other



CANNELURES ON METAL CASED BULLETS.

A Remington .44-40 bullet, showing knurled cannelure, deeper at the front edge, so as to conform to the bend formed on the mouth of the case by the crimping operation.

B .45 Automatic bullet of Remington make, showing a lightly knurled line around the bullet just forward of where the mouth of the cartridge case comes in assembly. This is not, strictly speaking, a cannelure but is really only a line of knurling, and as it is forward to the real location of the cartridge mouth, it does not in any way assist in holding the bullet in place. It is a factory designation or an ornament only.

C .455 Webley Self-loading Pistol cartridge. Note the fact that the cannelure, of the same general form as that shown at A is not knurled, but instead, is smooth on its sides and bottom.

D .33 Winchester soft point rifle bullet, showing wide cannelure of curved section, with the bottom knurled.

E .50 caliber machine-gun bullet of early design, with a very shallow cannelure, lightly knurled with diagonal marks. It was too shallow to afford a firm seat for crimping the neck of the cartridge case; it really did little more than add to the friction.

F Later design of .50 caliber machine gun bullet. The location of the cannelure was changed by moving it forward, and it was made wide and deep, of rectangular section, and the bottom was deeply knurled.

reasons, the bullet must be held firmly in place in the neck of the cartridge.

Therefore, in most cartridges with metal jacketed bullets, it will be found that there is a cannelure rolled into the metal of the jacket at the point where the end of the case comes, and the case is crimped into this cannelure. This is the practice in America; but in Europe, quite a different method is often employed. Especially in rifle cartridges they use what is called the segmental crimp, where the neck of the case is compressed into the soft metal of the bullet by having the cartridge put into a fixture where several jaws close in onto the neck of the cartridge at the same time; each jaw covers one segment of the circumference, hence the name. Another very popular European method is to make a groove or smooth cannelure in the bullet at some point which will lie inside the neck of the cartridge, and then indent several segments of the neck into this groove. This system is found in both rifle and pistol cartridge.

While the main function of the cannelure in metal cased bullets is to form a seat for the crimping of the cartridge case, as has just been described, it may and often does serve other purposes. With a soft nosed bullet having the front end exposed, and a jacket over the base, the maker may feel that several rows of knurling will help to hold the jacket to the core of the bullet and avoid the possibility of having the jacket stick in the bore of the gun, while the core goes on, a thing that has been known to happen. The writer has before him at this instant a .33 Winchester bullet of this type, with three knurled cannelures, of which one is used as the crimping groove, and the other two are covered by the neck of the cartridge case. This was formerly common practice, but the advent of thicker jackets has rendered it unnecessary, and today only one cannelure is ordinarily seen on full jacketed bullets.

Then there are several distinctive markings that are put on bullets in connection with some patented system of causing them to expand or mushroom, in order to increase their effectiveness for hunting. For example, one type has a jacket extending all the way up to the point, which has a small hole in it; and near the point the jacket has a row of slashes or indentations running back toward the base for a short distance. These are for the purpose of assisting the bullet to break up or enlarge on impact, in order to deliver a more smashing impact and give a more killing wound. Another type of recently developed hunting bullet has an enlarged portion, or band, running around it behind the point, to confine all the breaking up to the front part and retain the rear portion intact.

Any and all such distinctive marks may be of the very greatest assistance to the investigator in determining such interesting and useful information as, for example, whether or not the fatal bullet is of the same kind as several unfired ones found in the magazine or unfired chambers of the suspect's weapon, or in a partly used box of ammunition in his possession. The possible importance of such observations may be judged by the fact that the author has just this moment pulled the four bullets from four different makes of .30-'06 rifle ammunition, each of which had but one crimping groove rolled into its side; yet there was absolutely no difficulty in matching each make with the aid of a simple pocket lens.

Hand Loaded Cartridges

In addition to factory made ammunition manufactured and loaded by the various commercial makers, there is always the possibility that the investigator may encounter an instance where "hand loaded" or home made ammunition has been used; for many target shots and gun experimenters make a practice of casting their own bullets and then loading them by hand into cartridge cases, which may be either new primed cases purchased for this purpose, or fired cases which have been reprimed. Reloading tools and materials are regularly made and sold, and it is really a comparatively simple matter for anybody to prepare hand loaded ammunition which is the equal in every respect of the average factory product.

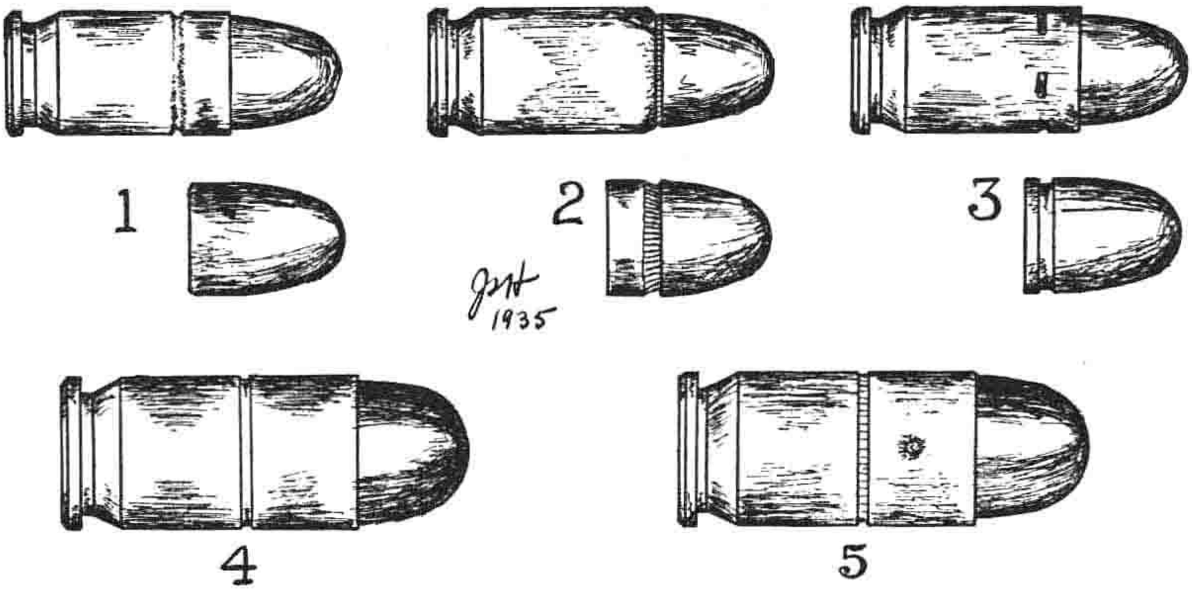
Any bullet which has been cast at home by the reloader can easily be told from the factory product. The hand cast bullet is made by melting lead and pouring it into suitable moulds. The lead is usually hardened by the addition of tin or solder, or sometimes of type metal, which contains antimony; or sometimes a special bullet alloy is purchased from the makers of reloading supplies. The molten bullet metal is poured into an iron or nickel mould, which is made in two halves, divided along the center line of the bullet, and hinged together. No matter how perfectly the bullet is cast, it is always possible to see the ridge or dividing line which runs lengthwise of both sides and across the nose of the bullet, marking the place where the joint came between the two halves of the mould. Moreover, the bases of home cast bullets, except the specially cast hollow base type, will be square across, and not cupped or hollow, as are most of the factory made ones; and there will be a small rough spot, where the "sprue" was cut off by the swinging gate through which the pouring is done. In rare instances, the hand loader may cast hollow base bullets; in moulds for these bullets, the swinging gate is at the point, and it will therefore always be flat, or nearly so, because the sprue will be cut off there.

An experienced shooter can tell at a glance whether a bullet is hand cast or factory swaged. The hand cast bullets have a brighter and more silvery look than do the factory made ones, and the lubrication and crimping grooves are cast into the bullet, and show the same shade of metal. Factory made bullets usually have the grooves rolled or knurled into the body as a separate operation, and these grooves are often made in corrugated, knurled, or pin-head patterns. Factory bullets usually have the base slightly concave, or dished in, or have a raised rim around the edge, and the surface will have a dull oxidized look, with slight dents all over it, which are caused by the manner in which hundreds of pounds of these bullets are handled and kept together in factory trucks and containers. The color and character of the lubricant may be a further guide, as the factories use a light colored lubricant with a wax base, while the individual is likely to use a softer mixture, dark brown in color, known as "Banana Lubricant" because it smells somewhat like a banana.

No one can predict what combination of components or calibers may be prepared and used by the experimentally inclined individual. It is entirely possible to load pistol bullets into rifle cartridges and shoot them with perfect results, or to do many other things which would cause the inexperienced investigator no end of perplexity, but if the student will take pains to become familiar with the practices of hand loaders, and with the appearance of their products, he should have no great trouble from this cause.

Crimping the Bullet in the Case

Obviously the bullet must be held fast in the cartridge case in some way, so that it will not move from its position from the force of recoil or from any other reason. Most commonly the bullet is provided with a crimping groove, or cannelure, and the open end of the cartridge case is rolled, pressed, or otherwise crimped over into this groove, so as to hold the bullet firmly in place. Some metal jacketed bullets do not have any cannelure, and are held in place merely by friction. An example is the .45 caliber automatic pistol bullet, which as made today, is proportioned so as to be a tight fit in the neck of the case; and is forced into place, where it is held by the elastic tension of the brass which was stretched when the bullet was inserted. Sometimes, however, these bullets are further held by "stabbing" three little dents into the brass with a sharp punch, so that the brass is driven more or less into the surface of the jacket. This stabbing is rather often found on automatic pistol bullets. Such stab marks will remain after the bullet is fired, and are very distinctive in appearance.



CRIMPS ON PISTOL CARTRIDGES.

1. Remington .380 pistol cartridge, in which the bullet is pushed in against a cannelure in the cartridge case, and is kept from coming out merely, by friction.

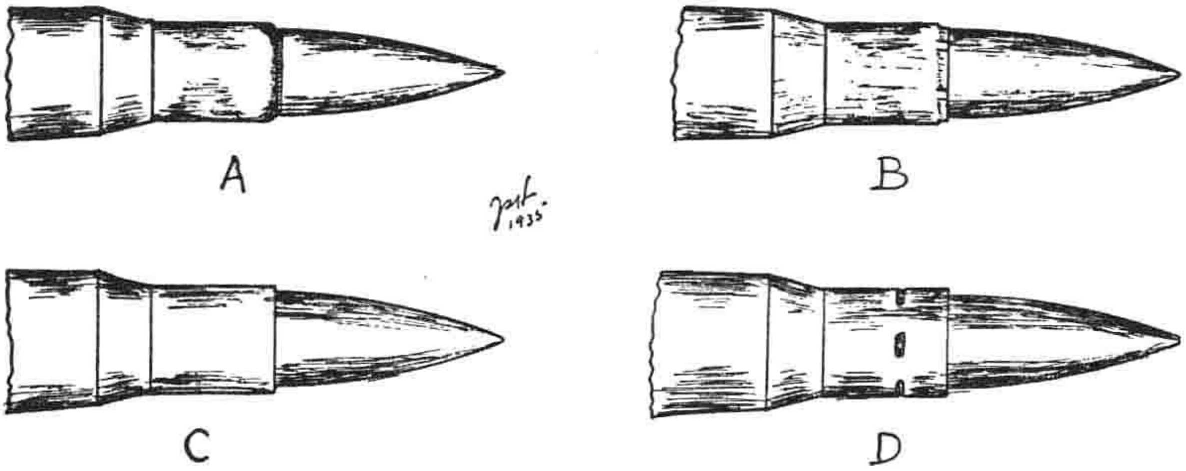
2. A later Remington .380 Pistol cartridge, in which the neck of the cartridge case is crimped into a deep cannelure in the bullet. Not the best practice, for this is strictly a rimless case, which depends on a good square shoulder at the front end of the case to stop it at its proper seating in the chamber. "Semi-rim" cases, like the .25, .32, and .38 A.C.P. cases may properly be crimped in this manner.

3. A .380 pistol cartridge made in Germany. The bullet carries a deep, smooth cannelure, and the case is indented into this cannelure at several places. An excellent way of holding the bullet in place, but not any too good for accuracy.

4. A .45 Automatic Cartridge, in which the bullet is seated against a cannelure in the cartridge case, and held friction tight in the neck of the case. This is the usual construction for this cartridge.

5. A .45 Automatic Pistol Cartridge in which the bullet is held in place by the "stab crimp," where the case is stabbled into the bullet in three points evenly spaced on its circumference. This method of holding the bullet in place is fairly common. The stab marks show plainly on the bullet after firing.

Besides the ordinary circular crimp, there are at least two other types of what is termed the segmental crimp, in which the cartridge case is pressed in over only a part of its circumference in three places. Some English cartridges have a cannelure on the bullet somewhat below the mouth of the case, and the crimp dents the case into this cannelure in three wide segments. In the German service rifle cartridge, and some others, the segmental crimp is used at the very mouth of the case and there is no cannelure, the bullet jacket merely being dented in under the pressed-in portions of the case. The segmental or partial crimp is not used in American manufacturing practice, and stab crimps are seldom seen in American cartridges today, though they were used to some extent in the past.



DIFFERENT CRIMPS ON MILITARY RIFLE CARTRIDGES.

A The .30 Caliber M1 cartridge, with the end of the case crimped firmly into a deep cannelure in the bullet.

B German 7.9 MM Mauser cartridge, with the bullet held in place by the "segmental crimp" in which the end of the cartridge case is pressed into the bullet by the action of several segmental jaws, which close in on the end of the case neck from all directions in making the crimp.

C .30 caliber National Match Cartridge, in which there is no cannelure, and the bullet is held by friction only. This puts a heavy strain on the metal in the neck of the case, which will usually crack after two or more years of storage. This illustration should not be construed to mean that all National Match cartridges are made without cannelure, for the design changes from one match to the next, and the only way to know about the national match cartridge for any particular year is to consult the specifications for the year in question.

D .303 British cartridge, with a groove around the bullet, into which certain segments of the neck of the cartridge case are pressed, as indicated.

SHOTGUN AMMUNITION

The ordinary shotgun cartridge, or "shell," as it is more often called, is made with a paper body and a brass head or "base." When not loaded, this component is called a "case," and the cartridge when fired is among other names, referred to as an "empty." In very rare instances, shotgun ammunition is made with an all brass case, like that of a rifle cartridge.

The shotgun cartridge is a center-fire affair, primed just like a center-fire rifle or pistol cartridge, and is loaded with powder, shot, and wads, in the following order. First, there is the charge of powder, which may be either black powder or one of the various kinds of bulk or dense smokeless powders. This powder is tamped down and held in place by two or more (generally three) thick wads. Then comes the charge of shot and on top of this is a thin, but stout, cardboard wad which closes up the end and holds the shot charge in place. The end of the paper case is turned over, or "crimped" down on the thin top wad, thus holding the components all firmly in position. Usually this top wad has the name or trade-mark of the maker, and the size of the shot, and sometimes the load of powder, stamped on one or both of its sides.

There are but few sizes, or calibers, of shotgun cartridges made, and the size of a shotgun or its ammunition is not referred to in "calibers," as is rifle or pistol ammunition, but instead, is named by the "gauge" or "bore;" though there are a few exceptions, such as the foreign 9 MM shotguns, and the popular .410 gauge, which strictly speaking is a .41 or .410 *caliber,* though in keeping with the usual shotgun practice, it is always referred to as .410 *gauge.*

The word "gauge," used in this connection, was originally derived from the diameter of a solid lead ball which would just fit the gun, and indicates the number of those balls that will go to make up a pound in weight. Thus a 12 gauge gun would be of such a diameter of bore that a ball of the same diameter would weigh 1-12th of a pound, and in the same way, a 16 gauge ball would weigh one ounce. But the balls now loaded to be fired as solid or single ball loads in shotguns are smaller than these figures would indicate, in order to allow for the choke of the muzzle, which is a constriction intended to prevent the shot pattern from spreading too much at long ranges. Modern American shotguns come in 10, 12, 16, 20, 28, and .410 gauges. In addition, but now obsolete in the United States, there are 4, 8, 14, and 24 gauge arms. The 8 gauge, and sometimes even 4 gauge guns are still occasionally seen, but the writer has never known of the use of a 14 or 24 gauge gun in this country. In the rural and backwoods sections the size of a shotgun is often referred to as its number; thus a man may go into a store to buy some "No. 12" shotgun shells or may tell you he uses and prefers a "No. 12 gun."

One soon learns to determine the gauge of a shotgun, its ammunition, wadding, etc., by eye alone; but in case of doubt, a comparison with unfired components will soon settle the point. However, for the benefit of those who may desire to know the accurate dimensions, we give below the diameters of the standard shotgun bores and also the diameter of the wadding. It will be noted that the diameter of the wadding is greater than that of the gun bore. This is proper and customary, but in actual practice the wad diameters will vary considerably and may be much greater than the figures given, particularly in the case of the soft felt wadding which must act as a gas check, and seal the bore while the shot are traveling out ahead of the powder gases.

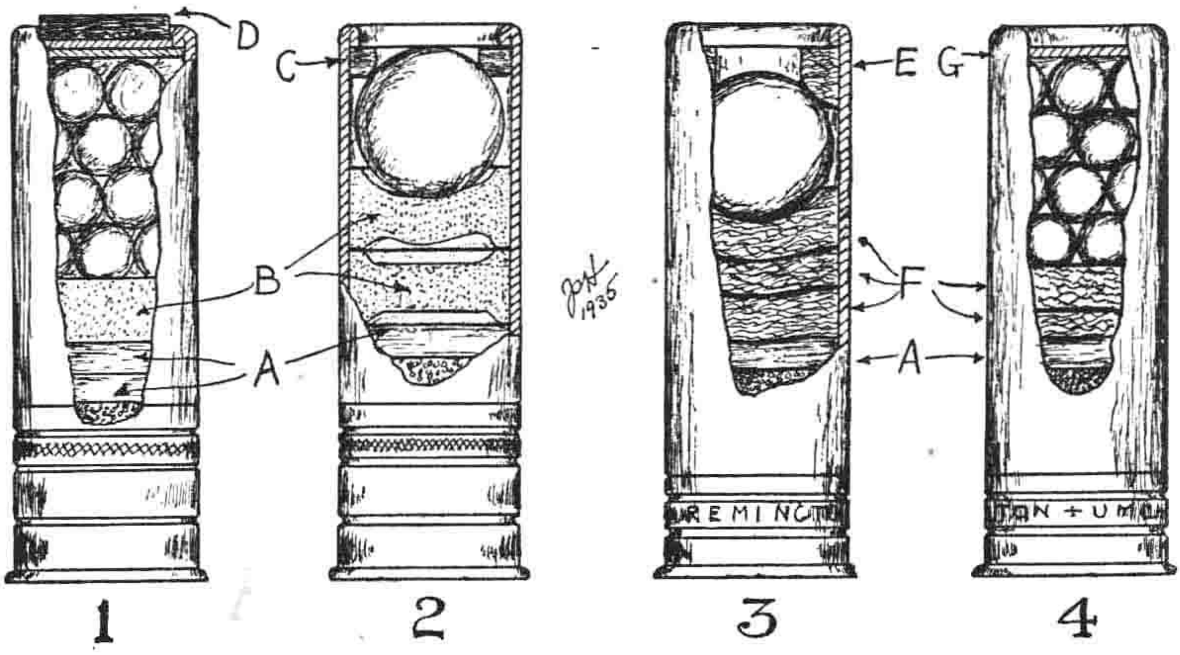
TABLE OF SHOTGUN GAUGES

Gauge	*Diameter of Bore*	*Diameter of Wadding*
8	0.835 inch	0.845 inch
10	0.775 "	0.784 "
12	0.729 "	0.738 "
16	0.662 "	0.671 "
20	0.615 "	0.623 "
28	0.550 "	0.557 "
.410	0.410 "	0.415 "

Various different types of shotgun cartridges are regularly loaded and sold. Most common are the ordinary hunting and trap loads, containing an ounce, more or less, of small shot. Depending on the game for which these cartridges are intended, or the purpose, such as trap shooting for which they may be used, they are loaded with different sizes of shot ranging from .15 inch in diameter for No. 2 shot to .08 inch for No. 9 shot; larger or smaller sizes are not often used. The two commonest sizes used in hunting are No. 6, which is .11 inch in diameter, and No. 7½, which is .09½ inch in diameter.

Next in size and range come the buckshot loads, containing a charge of from six to twenty-some individual large round lead shot, or more properly speaking, small lead balls. Then one finds shotgun cartridges regularly loaded with a single round ball, or with a specially shaped patented projectile, supposed to give the same killing effect as the round ball, but with greater accuracy. These single ball loads are sometimes carried by hunters with the shotgun in country where large game animals are likely to be encountered, with the idea of changing from a bird-shot load to a single ball load in case a large animal is sighted. The accuracy of these round shotgun balls is poor, for as mentioned above, they must be made small enough to cause no damage in case they should be used in a choke bored gun, and they do not have the benefit of rifling. The patented shotgun bullets are much more accurate.

Various special types of shotgun cartridges are loaded and sold, among which are the ones with the patented single ball loads above described. A late development is the "tracer" cartridge, which has among the shot a capsule loaded with a chemical compound which is ignited by the flame of the powder, and burns brilliantly in flight, so that the user can see whether or not he missed his mark, and by how much. Such ammunition has some little vogue at present in Great Britain, but is not yet made commercially in the U. S. It has the disadvantage that the special capsule of tracer mixture does not have the same weight as the regular shot comprising the charge, and therefore does not really give an accurate picture of the travel of the charge. In addition, there is some question of a poisonous effect on the eater of the game in case the tracer pellet itself struck the bird.



BUCKSHOT AND SINGLE-BALL SHOTGUN LOADS

1. Western Super-X load of No. 0 Buck. There are 12 pellets, in four layers. Over the powder there are two thick cardboard wads, then one cork composition wad, concaved on top and bottom. Notable is the top shot wad, which is of a patented construction as shown, in order to protect the crimp when the shell is carried in the magazine of a repeating gun for long periods, and taken out of the gun and replaced many times, as is the case when the shell is used by guards armed with riot type shotguns.
2. Western Super-X single-ball load.
3. Remington single ball load.
4. Remington load of No. 0 Buck.

A—Thick cardboard, as greaseproof wads. B—Cork composition wads, made with the top and bottom dish shaped, or concave, as shown in No. 2. C—Annular cardboard wad, or "Doughnut wad" used to hold the single ball in place. D—Patented top shot wad to protect the crimp on buckshot loads used by guards, which will usually wear out from handling before they are fired. E—Annular felt wad, used to hold the single ball in place. F—Felt wads. G—Cardboard top shot wad.

There are two general types of shot in common use; soft, or drop shot, and chilled shot. Soft shot is, as its name implies, ordinary soft lead made into round pellets, while chilled shot is made from lead specially hardened by the addition of a slight amount of antimony. There is a vast difference between the hardness of the two kinds, as anyone can readily tell if he will just bite a few pellets between the teeth. A late development is the plating of shot with copper to harden the surface.

The investigator should familiarize himself with the appearance of the various sizes of shot, for the size can be told very closely by visual inspection after a little experince. With a half ounce or so of the pellets in the palm of the hand, it is possible to state the size of the shot with confidence after a little experience. A more precise way would be to measure the pellets; and for all sizes under No. 1, the diameter in hundredths of an inch subtracted from 17 will give the exact shot number. For example, if the diameter is 10 hundredths of an inch, it is No. 7 shot; if the diameter is 9½, it is No. 7½ shot, and so on. This method applies to unfired shot, but when recovered ones are measured, different diameters must be averaged, because the pellets most likely will be deformed or flattened, and a degree of judgment must thus be used. In the case of such recovered shot, it would be well to weigh a few of the recovered pellets and base the determination of the size on the results.

The following table gives the diameters and weight in grains of the different sizes of shot, including buckshot and round ball.

TABLES OF SHOT SIZES AND WEIGHTS

LEAD BALLS

Name	*Diameter in Inches*	*Diameter in Millimeters*	*Approx. No. of Balls per Lb.*	*Weight in Grains*
10-Gauge	.710	18.03	13½	520.0
12-Gauge	.645	16.38	17	412.0
16-Gauge	.610	15.49	20½	342.0
20-Gauge	.545	13.84	28½	246.0
24-Gauge	.542	13.76	29½	238.0
28-Gauge	.510	12.95	35	199.0
½-Inch	.500	12.70	38	189.0
.45—5 Armory Practice	.452	11.48	50	139.0
.44 S. & W. Russian Gallery	.428	10.87	58	118.0
.44 Game Getter	.425	10.79	60	116.0

BUCKSHOT

Eastern Size	*Diameter in Inches*	*Diameter in Millimeters*	*Approx. No. of Balls per Lb.*	*Weight in Grains*
000	.36	9.14	103	68.0
00	.34	8.64	122	57.5
0	.32	8.13	144	48.5
1	.30	7.62	175	40.0
2	.27	6.86	238	29.5
3	.25	6.35	299	23.5
4	.24	6.09	341	20.5

SOFT SHOT

Eastern Size	*Diameter in Inches*	*Diameter in Millimeters*	*Approx. No. of Pellets per Oz.*	*Weights in Grains*
FF	.23	5.84	24	18.2
F	.22	5.59	27	16.2
TT	.21	5.33	31	14.1
T	.20	5.08	36	12.2
BBB	.19	4.83	42	10.4
BB	.18	4.57	50	8.8
Air Rifle	.17½	4.44	55	8.0
B	.17	4.32	59	7.4

SOFT AND CHILLED SHOT

			Soft Shot		*Chilled Shot*	
No.	*Diameter in Inches*	*Diameter in Millimeters*	*No. to the Ounce*	*Weight in Grains*	*No. to the Ounce*	*Weight in Grains*
1	.16	4.06	71	6.16	73	5.99
2	.15	3.78	86	5.08	88	4.97
3	.14	3.53	106	4.12	109	4.01
4	.13	3.30	132	3.31	136	3.21
5	.12	3.02	168	2.60	172	2.54
6	.11	2.79	218	2.00	223	1.96
7	.10	2.54	291	1.50	223	1.46
7½	.09½	2.41	338	1.29	345	1.26
8	.09	2.28	399	1.10	409	1.06
9	.08	2.03	568	.77	585	.75
10	.07	1.78	848	.52	868	.50
11	.06	1.52	1346	.33	1380	.32
12	.05	1.27	2326	.19	2385	.18
Dust	.04	1.02	4565	.10	....	..

The above tabulation gives the sizes of what are known as American Standard Shot, and these specifications are pretty generally adhered to. However, one may occasionally find a particular maker loading shot that will measure between these sizes; this is done to obtain a higher pellet count to the pattern, or something of the kind, with shot of approximately the designated size. It is the practice of some loading companies to vary the sizes slightly; thus they may actually have three separate dimensions of the larger sizes of shot, as, for example, Small Sixes, Sixes, and Large Sixes. The actual difference, however, will be so small as hardly to be noticeable, and can be told only by the slight variation in the number of pellets to the ounce.

In addition to familiarizing himself with the different sizes of shot, the investigator should make a close study of the wadding used by the different makers and learn to identify the various felt and cardboard gun wads. Many different materials, such as felt, linoleum, cork, paper, leather, etc., may be used in the manufacture of these wads, and sometimes certain patented shapes will be seen. Each maker has his own particular practice in assembling the different combinations with his own distinct colors and sizes, and a study of all this will help greatly in enabling the investigator to correctly identify any wadding which may be involved in an intentional homicide or a shooting accident with the shotgun.

It is, however, impossible to give all these data in a complete form for reference, as the practice of any maker is subject to change at any time, and what is correct today will perhaps be entirely different tomorrow. The investigator will do well to make a close study of shotshell loading practices and components and keep constantly abreast of current practices, with particular attention to improvements that are always being made in the art. It is an easy and entirely safe practice to cut open the paper case of a loaded shotgun cartridge and see accurately how it is assembled and how the different components are used. Cut a longitudinal strip from the paper case, dump the powder into a pill-vial, and preserve it and the wadding and shot for future reference and study, being careful to label it correctly as to maker, type and date.

Ammunition Terms and Names

Ammunition for the various type firearms is spoken of in several different ways, and distinctive terms are used in various sections of the country, any of which may be correct. The word "ammunition" of course means any unfired assembly of primer, powder and ball which might be used in a firearm; but today the word is generally used when referring to a supply of assembled cartridges in bulk, as in boxes, cases or carloads. However, "ammunition" is often used to refer to the supply a person may be carrying in his pockets, although the term "cartridges" is about equally applied.

Amongst the ammunition and firearms trade, shotgun cartridges are commonly referred to as "shotshells," while rifle ammunition is spoken of as "metallics;" further divided into "rimfires" (which are mainly .22 caliber in these days) and "centerfires," the latter comprising practically all calibers other than .22. When a trade representative uses the word "cartridge" he invariably refers to some rifle or revolver metallic cartridge; while in speaking of any shotgun ammunition he will use the terms "shells" or shotshells mentioned above.

The layman uses the above mentionel terms indiscriminately, although as a general rule he speaks of "cartridges" when referring to rifle or revolver ammunition, and "shells" when on the subject of shotguns. But a fired, empty, cartridge case is invariably spoken of as a "shell" also, although the backwoodsman might speak about "busted hulls" and still be in good social standing in his local court, even though "fired cases" is the strictly correct designation.

Amongst the uninitiated, the word "bullet" is most often misused as it is commonly applied to any sort of an unfired cartridge. Actually, the bullet is only that solid portion of a loaded rifle or pistol cartridge which leaves the muzzle of the gun, and which does the striking or killing. The word can really only be properly used in connection with rifle or revolver ammunition, but other common designations for the bullet are "projectile" and "ball," the latter a relic of old muzzle-loading days when all rifle projectiles were round, lead balls.

Although there are available in special type, various patented bullets for use in modern shotguns, they are seldom seen in this country and the word "bullet" is never correct in connection with shotgun ammunition as generally manufactured. The cloud of small, round projectiles which leave the muzzle of a fired shotgun are properly referred to as "shot," or as the "charge," or the "load;" while the individual round projectiles are properly termed "pellet" or "shot." The entire charge, when moving through the air, can also be properly referred to as the "pattern," although strictly speaking, the pattern is the registered strike of the entire load upon a paper target. Buckshot has its own peculiar appelations; the balls comprising the charge are often incorrectly referred to as "slugs," while in many backwoods sections, particularly in the South, they may speak of the larger sized buckshot as "blue whistlers" or "whistlers" while the smaller sizes are called "low moulds." The use of the round, single lead ball in shotguns is very greatly restricted in this country, but is popular to a degree in some of the mountain sections of the East; such loads are often locally referred to as "punkins" or "punkin balls."

In the chapter just completed, as well as the preceding one, the author has endeavored to define and describe briefly the commonly used, modern types of both firearms and ammunition. This subject has been treated from the viewpoint of, and for the use of, the police officer or lawyer who may have occasion to use this book, and who may not have had any great experience with firearms. It is possible that there may be some readers who may wish to go more deeply into the subjects just discussed, and for their benefit it may be said that there are in existence several excellent and suitable textbooks. In particular, I can recommend "The Book of the Springfield" by Capt. E. C. Crosman, which is a most thorough and interesting work on high velocity rifles and their ammunition; and "Modern Shotguns and Loads" by Capt. Charles Askins, which is an equally authoritative work on the shotgun and its loads and ballistics. Both these volumes are produced by the publisher of this book.

CHAPTER 4

POWDERS AND EXPLOSIVES

ANY user of a pistol or revolver should be interested in knowing as much as possible about the gunpowder which drives the bullet out of his weapon; and the firearms expert, especially the expert who expects to testify in court, must have a thorough knowledge of the principles of explosives, and at least a general knowledge of what types are in existence. For that reason this chapter describes gunpowders and explosives in general without being confined to pistol powders only, on the principle that the reader who is not interested in going deeply into the subject may easily skip any portion not interesting to him, but which may be very useful to some other reader, especially the firearms expert.

The name "Powder" applied to bullet propellants is an interesting example of the way in which the original meaning of a word may be changed by common usage. "Powder" originally meant, and still does mean, fine dust; but at the present time we find substances called powder which do not in any manner resemble dust and which are not even finely divided. For instance, cannon powders are ordinarily made in big grains several inches long and perforated with longitudinal holes; or flat strips an inch wide and a foot or more long; or even in tubes four or five feet in length. The word "powder" was first applied to propellants used in firearms because the first propellant was a black dust or powder composed of ground up charcoal, saltpeter, and sulphur.

The reason that this mixture explodes when ignited is that it contains two fuels, charcoal, and sulphur, which are very easily inflammable; and in addition it contains another solid substance which when heated gives off large quantities of oxygen. If charcoal and sulphur are mixed together in the air without the saltpeter, the result is a black substance that looks in all respects like the primitive gunpowder described above, and if it is ignited, it will burn, provided that plenty of air is supplied to support the combustion. The oxygen in the air enters into combustion with the charcoal to form carbon dioxide gas, and with the sulphur forms sulphur dioxide gas. However, there is no explosion because these gases can be formed only as fast as air can be brought in contact with the burning powder to supply the necessary oxygen for the combustion. In other words, this mixture of sulphur and charcoal would be a non-explosive powder.

Now when we mix powdered saltpeter with it, we change its nature so that it becomes an explosive powder. The minute it is lighted it burns all at once without waiting for any air to come in contact with it. This is because the saltpeter is very rich in oxygen which it gives up when heated. Thus the gun powder supplies its own oxygen for combustion from within and can burn without any outside air.

As nearly half the products of combustion of gun powder are gases which occupy a great deal more space than the solids from which they were evolved, it is evident that the combustion of gun powder results in a sudden expansion from the size of the original powder to the much larger size occupied by the gases which are driven off. It is this sudden expansion which causes the gun powder to exert force when it is ignited. The heat of combustion adds to this effect because hot gases occupy more room than cold ones.

Black powder relies for its explosive properties on three qualities which are typical of all explosives. First, when ignited it will burn by itself without aid from the outside air, and this burning is very rapid. Second, in burning, it gives off a large amount of gas. Third, a considerable amount of heat is also evolved.

To be successful for use as an explosive, a substance must possess all three of these qualities. We have seen above that there are substances which will burn and will give off a large amount of gas and heat, such as the mixture of charcoal and sulphur, but they do not burn without the aid of the outside air and consequently they do not burn rapidly enough.

We do have substances that will burn without the aid of outside air and burn rather rapidly, but they must also give off a large amount of gas or else there is no explosion. Thermite, which is a mixture of oxide of iron with aluminum powder, will burn rapidly without air when ignited and it gives off great heat but it does not give off any gas, and therefore, there is no explosion. When this powder is burned it forms melted iron and slag which is aluminum oxide.

Even though a substance can change from a solid to a gas without the addition of oxygen from the outside air, there will be no explosion unless the change from a solid to a gas involves the liberation of heat. Some substances change into gas rather rapidly, but in doing so, instead of giving off heat they take up heat. Substances such as these do not cause an explosion when they decompose because as soon as they have started to decompose, they chill the surrounding air so much that the action comes to a stop until more heat can be supplied. A very familiar example is the "dry-ice" in which ice cream is often packed. This is solid carbonic acid gas, and can exist in solid form only at an extremely low temperature. The minute dry-ice is exposed to air, it begins to give off great quantities of gas, but in giving off this gas it absorbs all the heat around it so that the gas can only be evolved as fast as the heat is supplied. Thus you can lay a big chunk of dry-ice on a hot stove and it will sizzle, hiss and jump around for a long time but there will be no explosion.

The basis of gun powder is the substance which gives off oxygen, and that is the saltpeter. No doubt the original invention of gun powder followed the discovery that when saltpeter is thrown into a fire, it crackles, hisses and makes the fire burn very much more brightly because of the oxygen it gives off. Then by mixing this saltpeter with incendiary materials, it was found that extremely hot fires could be made when the mixture was ignited. Finally, no doubt the proper combination was obtained so that when one of these mixtures was ignited it went off with a real explosion.

The actual discovery of gun powder is variously ascribed to the Hindoos; to the Chinese; and to Roger Bacon, a German monk who seems to have described its composition in a manuscript written in 1249. Whoever may be the true inventor of gun powder, guns and cannon were known before 1350 A. D. From this time until the discovery of gun cotton in 1846, black powder was the only explosive commonly known and used.

The average composition of black powder is saltpeter 75 parts by weight, sulphur 10 parts, and charcoal 15 parts. There is, however, quite a wide variation in compositions that have been used in different years. Powders used for blasting, for example, are more effective if they do not operate quite as quickly as the ordinary gun powder. This is for the reason that in blasting it is desired to rend the rocks and tear them out in chunks, rather than to break them up in fine pieces, which a stronger powder would do. The average blasting powder would have about 70 parts saltpeter, 14 sulphur and 16 charcoal, but some powders of this kind have been made with compositions as low in saltpeter as 40 parts, 30 sulphur and 30 charcoal.

The speed of burning of black powder, and therefore to a certain degree its strength, is controlled by the size of granulation. Powder with extremely large grains burns more slowly than a fine grain powder and, therefore, is less sudden in its action. Moreover, large grain powder is much harder to ignite.

As the size of the granulation decreases, the strength of the powder increases up to a certain point. However, when a powder is made very fine, like dust, the speed of burning is again reduced, because all the spaces between the grains are filled up, and hence there is no way for flame to communicate itself rapidly through the spaces and ignite the whole charge at one time, as would occur with powder where there is somewhat larger granulation. Powder with very small grains is the easiest to ignite, however, hence this kind of powder was used for priming charges in the old muzzle loaders.

Black powder as at present made and sold to the trade comes in irregular, shiny, metallic looking black grains designated as to size by the letters FG, FFG, FFFG, etc.; the more F's, the finer the grain. There is also a special granulation used in the Army for saluting purposes called Grade A-1. I have often been asked just what these different designations mean as to size. This is a rather difficult question because the designations vary with the different manufacturers, but taking the du Pont Company's system the values would be as given in the table below.

The powders are measured by screening them through a coarse screen which catches all the very large lumps, letting the rest fall onto a fine screen which allows all the very fine powder to pass through. The screens through which the different grades of powder must pass and on which they must be retained are given in the table, the figures representing the number of meshes per inch in the screen.

Size	*Must Pass*	*Must Be Retained On*
Grade A-1	6	10
FG	14	16
FFG	16	24
FFFG	24	46
FFFFG	46	60

Nitro-Explosives

The discovery of nitroglycerin in 1846 opened a new field of explosives. Nitroglycerin is one of the strongest explosives known and is the basis of many modern explosive compounds. It is a colorless, oily liquid formed by the action of nitric and sulphuric acids on glycerin.

Nitroglycerin differs from gun powder in that it is not a mixture of fuels and oxidizing agents. Instead, it is a chemical compound containing a large amount of oxygen, and this chemical compound is capable of re-arranging itself into more stable compounds which are gases. A sharp shock will cause this rearranging process to start, and when once started it spreads almost instantly throughout the entire mass, thus resulting in a violent explosion.

Nitroglycerin is inconvenient to use by itself, as it is subject to leakage and thin films of nitroglycerin leaking out on the outside of containers are subject to friction which might easily cause disastrous explosions. Moreover, pure nitroglycerin is dangerously sensitive. It was soon found that unless something could be done to overcome these disadvantages, nitroglycerin would never attain great popularity as an explosive.

The difficulty was finally overcome by the discovery that nitroglycerin absorbed into a porous substance made a much safer and more convenient explosive than the pure nitroglycerin. One of the most successful methods of using it was to allow the nitroglycerin to be absorbed in a porous earth called Kieselguhr. Nitroglycerin absorbed in a porous substance of this kind is called Dynamite.

Another very powerful explosive, which like nitroglycerin is a chemical compound and not a mixture, is gun cotton. This is formed by the action of nitric and sulphuric acid on cotton or any other kind of cellulose. Hence we often hear the term nitrocellulose used instead of gun cotton. Gun cotton has the quality of being a substance which burns with extreme rapidity. It is said that it burns so fast that some black powder grains may be laid on gun cotton and if the gun cotton is ignited it will burn out from under the black powder grains without setting them on fire.

Nitroglycerin and gun cotton, or Nitro cellulose, are only two of a whole series of nitro-compounds which have very powerful explosive properties. Another well known substance of the same general kind is tri-nitro-toluol, or, as it is commonly called, T. N. T.

It will be remembered that gun powder is merely a mixture of two fuels and one oxidizing agent, whereas gun cotton and the other nitro-explosives are definite chemical compounds. Such compounds in general explode more violently than simple black powder and are known as high explosives. Moreover, there is a big difference in the manner of explosion of a high explosive as compared with black powder. When black powder is ignited it burns with very great rapidity, giving off a large volume of gas, and this burning is the only explosion that occurs. On the other hand, many high explosives such as gun cotton, nitroglycerin and T. N. T. can be burned without causing any explosion at all. A stick of dynamite, for example, can be cut up and thrown into a fire bit by bit with very little danger of exploding, though each piece will burn rather intensely. In the same way, T. N. T. can be burned in large quantities without any explosion occurring.

What these high explosives need to cause them to exert their full power is a shock which starts a chemical rearrangement of the molecules into gas instead of solids. This chemical rearrangement is called a "detonation." Once a detonation is started in a high explosive, it spreads through the entire mass with a sort of wave action with great rapidity. The speed of detonations varies in different explosives but in some it is as high as 7000 yards in a second. A detonating fuze consisting of a long thread of T. N. T. encased in a lead covering, will thus set off a number of charges of explosive almost instantly if a detonating cap is exploded at one part of the fuze. Ordinarily the detonation of high explosives is started by exploding a blasting cap in contact with them. These blasting caps contain fulminate of mercury, a substance that explodes with great suddenness and which seems particularly well adapted to producing detonations.

Owing to its porous nature, dry gun cotton burns with extreme rapidity, and moreover, it detonates with violence from a moderate shock. However, when it is moistened with 25 per cent of its own weight of water, it becomes safe to handle, for it can be burned only with extreme difficulty, and it can be detonated in this state only by exploding a priming charge of dry gun cotton in contact with the mass of wet cotton. But when it does detonate, it is just as powerful as the dry cotton. For many years, wet gun cotton was used as the explosive charge in submarine mines and torpedoes. As long as the dry gun cotton priming charges were kept out of contact with the wet mass, it was perfectly safe to store or handle.

After the discovery of nitro-explosives, an attempt was made to use them for propellants in guns, but they detonated with such instantaneous violence that they would simply blow the gun all to pieces before the bullet had time to move. To make them suitable for use in guns, it was necessary to find some way to prevent them from detonating, and to slow down the burning to a reasonable speed. This was finally accomplished in the case of gun cotton, which now forms the basis of most of our smokeless powders. Instead of leaving the nitro-cellulose in a light and fluffy form, it is dissolved in some solvent, and then evaporated into a glue-like mass, or colloid, which detonates with difficulty or not at all, and which burns with a reasonable speed.

One of the earliest successful smokeless powders was made by dissolving gun cotton in nitroglycerin, and adding about 5 per cent of vaseline, and afterwards extruding the soft mass into long cords. This is the British propellant called Cordite, which is composed of 37 parts gun cotton, 58 parts nitroglycerin, and 5 parts vaseline.

Another explosive formed by mixing gun cotton and nitroglycerin is blasting gelatin. This mixture is a very fortunate one chemically because gun cotton has insufficient oxygen in it to turn all its carbon completely to carbon dioxide and nitroglycerin has too much oxygen. By mixing the two substances in proper proportions, the excessive oxygen in one explosive supplies the deficiency in the other and the products of the explosion of such a mixture are nitrogen gas, carbon dioxide gas, and water (in the form of steam).

Many of our most popular rifle and pistol powders of today are made by dissolving gun cotton in nitroglycerin, and then forming the resultant mass into small grains or flakes. Examples are the well known rifle powder Hi-vel, and the pistol powder Bullseye. These powders, made with both nitro-cellulose and nitroglycerin, are usually called nitroglycerin powders, or Double Base powders.

Another method of making nitro-cellulose into smokeless powder is to dissolve it in a mixture of ether and alcohol, thus forming a sticky mass having very much the same consistency as melted glue. This mass, called "colloid," (meaning "glue-like"), is then extruded into little tubes like fine macaroni, and these tubes are cut into short lengths, after which the ether and alcohol are evaporated off, leaving a hard substance something like dried glue. This dried out colloid of gun cotton is what most modern smokeless powders are made of. A powder made in this way is called a nitro-cellulose powder, or a single base powder. Examples are the Government Pyro powder, used in the '06 Springfield Rifle cartridges; the duPont "I.M.R." or Improved Military Rifle Powders, such as the duPont I.M.R. 1147 and I.M.R. 1185 powders used in the latest M1 .30 caliber cartridges; duPont Pistol Powder No. 5; and many others.

Such smokeless powders are made in the form of flat flakes or small cylindrical grains with a hole running through the center. In other words, they are like little sections cut off of a fine tube of macaroni. The object of having the hole through the center of the powder is to control the rate of burning so as to hold the pressure of the powder up as long as possible.

The great trouble with getting high velocity in a gun is the fact that when the powder in the cartridge is ignited, it turns into gas and this gas confined into the small space of the cartridge case creates a very high pressure which pushes the bullet along the bore of the gun. But as soon as the bullet starts to move along the bore of the gun that leaves more space for the gas to occupy, hence there is less pressure, and the effect of the powder would rapidly fall off to nothing unless special means were taken to keep it up.

One of these special means is the perforation of the powder grain, which causes it to have a larger burning surface as the combustion proceeds. This is because the powder flash ignites the inside of the tube as well as the outside. As the grain burns the outside surface gets smaller, hence the rate of evolution of gas would tend to decrease. However, this is balanced off by the fact that as the inside of the grain burns, the inside surface gets bigger. Therefore, there is a larger surface on the inside for the evolution of gas as the combustion proceeds.

The balance between these two surfaces can be controlled by the ratio of the inside diameter to the outside diameter in the finished grain of powder. In cannon powders there are usually several perforations instead of one.

Another method of controlling the burning of the powder and making it more progressive, that is, making it hold up its pressure longer during the travel of the bullet, is by coating powder with a substance which makes it burn slowly at first. As this coating burns off the outside of the powder, the speed of combustion increases. These progressive burning powders tend to give a more uniformly distributed pressure, which is sustained longer during the travel of the bullet. Moreover the maximum pressure is not so high, because instead of being exerted all at once, the pressure is spread out more evenly during the entire travel of the bullet. The latest duPont "Improved Military Rifle" powder such as IMR-No. 17, IMR-No. 1147 and IMR-No. 1185 are progressive powders.

Like black powder, smokeless powders are controlled as to their speed of burning by the grain size also. Powders with very fine grains burn up in a hurry, and therefore are suited for short barrel weapons. Powders with very large grains take longer to burn up, therefore are suited to long barrel weapons.

For any given size of gun such as the caliber .30 rifle, there is a granulation powder that is suitable, and a larger or smaller size will either give too high pressures or will not burn up completely before leaving the barrel.

However, in the Springfield rifle the grains may be either long and slender or short and fat and still be about the same size. In general, better results are obtained if the grains are long and slender because this leaves bigger air spaces between the grain for the priming flame to penetrate and thus better ignition is obtained.

For example, the No. 1147 powder has tubular grains that are cut 22 to the inch and the No. 1145 has tubular grains cut 11 to the inch. In other words they are twice as long. Now these longer grains do not load as uniformly in a loading machine because they do not pack as well as the shorter grains. Some people knowing that you can get charges which weigh more nearly the same with the fine grain powder, insisted that it should be used for ammunition where great accuracy is desired. Tests, however, proved that the longer grains, even with charges which varied in weight, give better accuracy than shorter grains because in the shorter grains the ignition was irregular owing to the space between the grains being filled up so as to make it difficult for the primer flame to penetrate.

The rate of burning of the powders above described such as duPont and the Hercules Hi Vel, depends not only on the grain size, but also on the resistance that the bullet offers to being moved. If any of these powders are ignited in the open air they will burn slowly, the same as a pile of grains of celluloid, and there would be no explosion. On the other hand, when they are ignited in a gun the first grains burn and give off hot gases and these hot gases in turn accelerate the burning of the other grains. The more the gases are confined the hotter they are and the faster the combustion of the remaining powder will be. Thus with a heavy bullet or with the cartridge case full of powder, the combustion is more rapid than it is with a light bullet or with a cartridge case only partly filled with powder.

There are some powders which must burn with a big air space in the case and a light bullet. These are powders used for reduced loads. There are also powders which must burn with no resistance at all in the form of a bullet to hold back the gases. This is the case with powder used in blank cartridges where there is no bullet, but only a paper wad. This powder must burn with extreme rapidity under low pressure. The powder most used for this purpose is called "E. C. Blank Fire Powder."

We have seen that gun cotton burns with extreme rapidity. If we mix it with nitroglycerin it burns more slowly. If we should compress it or mix it up with glue or do anything to take away its fluffy consistency, it would tend to make it burn more slowly.

Following these principles, blank powder can be made by taking nitro-cellulose or some other nitro-compound such as nitro-lignin (nitrated wood) in combination with other suitable substances, and dampening the fluffy material with gum water, then rolling it into little balls or grains. Thus it is almost gun cotton; the violence of its burning is reduced by the fact that it is glued together by the gum water solution. Blank cartridge powder cannot be used with a bullet or charge of shot in the cartridge. The added resistance is liable to cause it to detonate and burst the gun.

A blank cartridge powder very commonly used in this country is called "E. C." (from the originators, the Explosives Company), and there is also a shotgun powder by this same name. I once had an acquaintance who got hold of some of this E. C. blank cartridge powder and being acquainted with E. C. shotgun powder, he decided that it was the same thing and loaded up some shot shells with it. The first one he fired lifted the side neatly out of one barrel of his L. C. Smith hammerless shotgun, but fortunately did not inflict any personal injury.

Powder for reduced loads is midway between blank fire powder and the regular rifle powder. It has to be fast burning because it cannot depend much on the resistance of the bullet, as it is used in small charges in big cartridge cases with lots of air space and it is also used with very light bullets. It is difficult to make a powder that will perform well under these circumstances, but this has finally been accomplished, and an extremely satisfactory powder of this kind is Sporting Rifle Powder No. 80 which was used with the gallery practice outfits issued to the Army some years ago.

Shotgun powders differ considerably from rifle powders. The shotgun is distinguished from the rifle not only in not having a rifled bore, but also in being usually of considerably greater caliber. To produce a weapon easy to handle, it is necessary to make the forward portion of the barrel very light. Therefore, there must be but little pressure except near the breech. Distribution of the shot in a uniform pattern seems to require that comparatively little pressure be exerted on the shot in the forward portion of the barrel. For these reasons shotgun powders must burn more rapidly than rifle powders and, therefore, there must be more surface exposed.

Shotgun powders are of two kinds, dense and bulk powders. Perhaps the best known dense powder is Ballistite. This is a nitroglycerin powder composed of gun cotton completely dissolved in nitroglycerin so as to form a homogeneous gelatin or colloid. It is then formed into small grains or very thin flakes. The advantage of this powder is that it leaves very little solid residue when burned, and is consequently free from smoke, and also leaves very little residue in the bore. It is little affected by moisture.

Bulk powders are a great deal lighter and more bulky than the dense. In fact, the term "bulk" means that the powder can be loaded bulk for bulk with black powder. In other words, you can load this powder by measure and can use the same measure for loading it as you would for loading black powder.

The first successful bulk powder was known as Schultz, after the inventor, Captain E. Schultz of the Prussian Artillery. This powder was made from nitro-lignin, or nitrated wood, mixed with the nitrates of barium and potassium.

Most of the modern bulk shotgun powders do not use nitro-lignin but use nitro-cellulose instead. One of the best known is duPont's Smokeless Shotgun Powder which is a straight nitro-cellulose composition throughout.

The great difference between black powder and smokeless powder is that in the black powder more than half the products of combustion (about 55.71%) are solids. These solids are principally potassium carbonate, potassium suphate, and potassium sulphide, and when they are ejected from the gun along with the powder gases they form a dense white smoke. A large amount of solid material is also deposited on the inside of the gun barrel so that with black powder a heavy fouling accumulates which necessitates cleaning after each ten or more shots.

With smokeless powder on the other hand, the products of combustion are almost entirely gases and water vapor, so that there is little or no smoke and little or no deposit in the gun barrel.

Besides the good old fashioned black powder and the smokeless powders above mentioned, there is a type known as semi-smokeless, which is a mixture of black powder and gun cotton. The Lesmok powder so much used in caliber .22 cartridges is of this type, and consists of 85 per cent black powder and 15 per cent gun cotton. The semi-smokeless powders are extremely accurate in .22 caliber loads, and while they have more smoke and fouling than the smokeless powders, the fouling is of such a nature that it does not cake or harden in the barrel, and firing does not have to be interrupted for cleaning the barrel. A disadvantage of Lesmok powder, which, however, does not affect the user, but only the maker, is that it is extremely dangerous to manufacture.

Pistol and Revolver Powders

A number of years ago all pistol cartridges were loaded with black powder; but it is dirty and very quickly fouls the barrel, so that after eight or ten shots the gun loses its accuracy unless the barrel is cleaned. Moreover, it gives an objectionable smoke and an extra heavy recoil.

The reason for this very heavy recoil with black powder has been explained in another chapter, which treats of interior ballistics. As mentioned above, black powders are designated by the grain size as FG, FFG, FFFG, etc.—the more F's the finer the grain. Very small cartridges use the finer powder, larger ones the coarser.

The black-powder cartridges are practically obsolete now, and should be entirely so. The only way in which the black powder has any advantage over the smokeless is in safety. It is not as much subject to erratic pressures from small variations in loading The only excuse that I can see for wanting to use factory-loaded black-powder cartridges at the present time is that the Remington Arms Company manufactures a black-powder .45 Colt cartridge which has more velocity than most smokeless-powder cartridges now on the market, and many shooters who want to get the maximum power will naturally use this cartridge with its 40 grain load.

However, they will pay for the additional power in a greatly increased punishment from recoil. Many years ago this was the standard load, but it was reduced in order to reduce the recoil, so that for a long time from 30 to 35 grains was the usual charge. Lately, with a number of experimenters trying to get higher velocities, the cartridge company decided to load a cartridge that would give the maximum safe velocity for those who needed an extremely powerful load.

They also load the .38 Special and several other cartridges with very heavy loads of black powder, thus safely obtaining velocities higher than the standard for smokeless loads.

Up until a few years ago, most .22 caliber cartridges for target practice, or for use in fine arms, were loaded with Lesmok powder, because smokeless could not be used without having the arms ruined from corrosion, even with the greatest care in cleaning. This was because the primers then in use were very corrosive, and the only thing that would save the barrel was a large charge of powder to dilute the products of the primer combustion and wash them out of the barrel. The smokeless charge of the .22 short was too small to do this, and excessive corrosion resulted. Even with the largest smokeless cartridges, great care and very prompt and thorough cleaning was all that would save the barrel. Now however, non-corrosive primers are almost universally used with smokeless pistol cartridges, and the smokeless .22 can be used with no danger at all of having the barrel corroded.

Smokeless powders for use in pistols or revolvers must be very much quicker in their time of burning than rifle powders, so that the powder can all burn up before the bullet has left the very short barrel used. Because the barrel is so short, the progressive powders now so popular for rifle use cannot be used in pistols. Pistol powders are made in the form of very fine thin flakes that burn practically all at once.

For many years one of the most popular powders for loading pistol cartridges has been Bullseye, which is a nitroglycerin or double base powder made by the Hercules Powder Co. The term "double base" comes from the fact that there are two principal ingredients, or bases, used in making the powder; nitro-cellulose, or gun cotton, and nitroglycerin which is mixed with or dissolved in the nitro-cellulose. This Bullseye powder has been used almost exclusively by some factories over long periods of years for loading most of their pistol cartridges. It is also one of the several powders that are standard for loading the .45 Automatic pistol cartridge by the Ordnance Department. Pistol cartridges that are not generally loaded with it are the three rifle cartridges that also may be used in revolvers, namely, the .32-20, the .38-40, and the .44-40, which are most often loaded with Sharpshooter smokeless powder as a compromise for either rifle or pistol use. This is also a double base powder made by the Hercules Powder Co.

An extremely popular single base, or straight nitro-cellulose powder designed especially for use in pistols and revolvers is duPont Pistol Powder No. 5. It is also standard for the Government .45 pistol cartridge.

Many of the older pistol cartridges, designed for black powder, have a case too large for the best results with extremely dense powders like Bullseye and duPont No. 5. For these cartridges, such as the .38-40 and .44-40, duPont Sporting Rifle Powder No. 80 is excellent. This is the type of powder known as "bulk" powder, described above, but it cannot, like the original bulk powders, be measured bulk for bulk with black powder, and the same loads used.

Identification of Black and Smokeless Powders

The appearance of black powder is quite characteristic, and once it is seen and carefully examined, it will always be easy to tell it from smokeless powder at a glance. Black powder is composed of irregular grains of a fairly uniform size, with a glossy black surface. There are various sizes, or granulations, of black powder used, but in any one cartridge the grain sizes will be fairly uniform, for the larger and smaller sizes are removed by screening, as was described earlier in this chapter.

Some varieties of smokeless powder also have a glossy black surface, but they look very different from black powder, in spite of the similarity of color. The smokeless grains have a perfectly definite shape, such as small squares, discs, or cylinders, with or without a hole in the center; while the grains of black powder are of the irregular shape caused by forming the damp mass into a cake, and then, when this cake has hardened, breaking it and crushing it into grains of the desired size, polishing the grains by rumbling them in a barrel, and then removing the large grains as well as the dust and very small grains by differential screening.

No smokeless powder is naturally black; the reason why some of it in the finished state has a black surface is because it is coated with graphite. This graphite coating is put on because the powder is a hard amber-like substance which is a non-conductor of electricity, and is very strongly susceptible to becoming electrified by friction, especially the friction of one grain on another in handling, loading, etc., so that in cold, dry weather the grains have a tendency to stick together and become difficult to load in even charges. Moreover, the occurrence of sparks of static electricity is a very serious fire hazard, especially when the air may contain highly inflammable volatile vapors of the solvent used in making the powder. Coating the surface with graphite makes it a conductor of electricity, and prevents trouble from this cause.

"Dense" smokeless powders are composed principally of a hard, translucent, horny *colloid* very much like celluloid, made by dissolving nitro-cellulose in a mixture of ether and alcohol, and then drying it out, as has already been described. It should be understood that there are several grades of nitro-cellulose, depending on the degree of nitration. The very high nitrogen product, or gun cotton, will not dissolve in ether and alcohol. The lower nitration nitro-cellulose will dissolve completely, and is used to make the powder known as "Pyro." A compound of high nitration cotton mixed into the pyro colloid forms the modern rifle powders known as the "I.M.R.," or Improved Military Rifle, series. Low nitration nitro-cellulose, colloid and then dried out, is also used to make celluloid, which is very much the same as some smokeless powders. In fact, finely chopped celluloid can be loaded into a cartridge and used to propel a bullet.

These dense powders are made in a variety of different sizes, from sticks perhaps four feet long to grains as small as ordinary sand. The rate of burning, and the maximum pressure, can be regulated by the grain size; the large sizes naturally burn more slowly than the small ones. Thus the cannon powders have very large sized grains, the rifle powders have smaller ones, and the pistol powders the smallest of all.

Cannon powders are usually of the natural color of the colloid, that is, a dark amber, and very frequently are seen in the shape of cylinders with seven holes running through from end to end. These tubular perforations control the rate of burning by allowing the ignition to take place inside as well as outside. As the outside surface burns, it gets smaller, and thus slows the rate of burning; but this effect is balanced by the fact that the inside surface gets larger as it burns.

Rifle powders are most usually in the form of small cylinders, with a single perforation through the center, and with the surface graphited, so that the color is a shiny black. Small flat squares are often seen.

Dense pistol powders are usually of a greenish brown color, and on close examination are seen to consist of small flat chips.

Bulk powders for both rifle, pistol, and shotgun are mealy in appearance, like fine sawdust, and the color may be grayish white, light yellow, cream color, gray, or pink. Other colors are sometimes seen, and are due to certain dyes or coloring substances used by some makers.

Lesmok or Semi-smokeless powders look like fine gray sand.

It is a comparatively easy matter for the student of powders to gather together a collection of the more common types and brands. Purchase a few dozen of the larger sized, empty pill phials and suitable labels to paste on the side of them. Collect all the different rifle cartridges, shotshells, etc., and break them down for examination; as a new powder is discovered, ascertain correctly its name, maker and characteristics, and place it in one of the phials, properly labeled. One soon learns to identify the various types of powder by sight, coupled with the knowledge of just what cartridge they came from. However, some of the modern, dense rifle powders cannot be identified accurately by sight alone, as many brands are of similar composition, type and grain size; only a trained laboratory worker can determine the identity of such powders.

It is often an aid in the diagnosis of the different kinds of powder to light a small pinch of it on some fireproof surface. Black powder will burn with a quick flash of white flame, usually with a purplish tinge, and will give a large puff of light gray smoke; and it will leave a heavy gray residue on the surface. As the powder flashes, a number of the grains will be projected through the air in the form of burning sparks. Frequently, in accidents involving black powder, these little particles of partly burned powder are driven into the skin of the victim, where they will leave a permanent tattooing of dark blue specks, unless each grain is carefully picked out.

When a small pinch of smokeless powder is ignited in the manner described above, it burns with a brisk yellow flame, and gives off no smoke. The residue left sticking to the cold surface consists of an irregular network of partly burned powder which has adhered to the metal, and has failed to burn entirely on account of the contact with the cool support. It is usually translucent and somewhat yellowish in color, with some charred material or graphite giving it a blackened appearance. The residue of black powder can be washed off readily, while that left by the smokeless is insoluble, except that in some bulk powders certain mineral salts, such as potassium nitrate are incorporated, and the remains of these salts, when present, will dissolve.

The flame of smokeless powder resembles that of celluloid, which is practically the same in composition as some smokeless powders. Like celluloid, smokeless powder burns with a hot, flaring yellow flame, and in small quantities in the open air, it burns at about the same speed. A large grain of cannon powder can be lighted with a match and then blown out. While this experiment is decidedly not recommended, the author has, as a demonstration, taken a grain of cannon powder in his hand, ignited it with a match, used it to light a cigarette with, and then blown out the half burned grain. But you cannot do this with black powder, or even with all kinds of smokeless powder. The author once saw a young man trying to light with a match a large grain of sphero-hexagonal black powder about an inch in diameter which was lying on an ash tray. An attempt was made to stop him, but before this could be accomplished, the grain ignited, with a sudden blinding puff of flame about three feet in diameter, which cost the foolhardy young experimenter his eyebrows and taught him very sharply the difference between black and smokeless powder, but fortunately did no real harm.

Smokeless powder, particularly of the single-base nitro-cellulose variety, is not sensitive to shock or friction, and is not dangerously easy to ignite, and moreover, when ignited in an unconfined condition, it merely burns with extreme rapidity and great heat, and does not explode. For these reasons, it is much safer than black powder to store or handle. One disadvantage that it has is the fact that in some varieties, chemical changes are apt to occur with age, and the powder then deteriorates. Fortunately, this deterioration always weakens the powder, so that there is no reason to be afraid to shoot old cartridges because the pressure might be high, for the powder always becomes weaker when deterioration sets in.

Occasionally, decomposing smokeless powder may give off brown fumes of nitrous oxide, which are highly poisonous and corrosive. And very often, the decomposition of smokeless powder may generate heat and thus start a fire by spontaneous combustion. This can occur equally well with celluloid when articles made of this substance are stored in bulk, for celluloid in some of its forms acts much like smokeless powder. On two separate occasions the author has observed instances where celluloid protractors or triangles stacked on the shelves of a warehouse have deteriorated almost to the point of combustion; and on another occasion he investigated a fire which proved to have originated from this cause. Again, he saw a safe in which the user had placed a large stack of celluloid protractors. When the safe was opened some months later, there emerged brown fumes, and some revolvers and other metal objects in the safe were badly corroded. The author was applied to for an explanation of the cause; and an investigation showed that the celluloid protractors, stacked together in one corner of the safe had turned to various mottled shades of opaque yellow, and were very badly warped and cracked.

Another object lesson on the decomposition of materials of this nature was the terrible accident a few years ago in a hospital in Cleveland, where spontaneous combustion occurred in a small room where x-ray film, (celluloid) were stored near steam pipes. The resulting nitrous fumes killed over a hundred patients in a few minutes.

The author happened to be in Baltimore in 1928 when a magazine containing 175,000 pounds of smokeless powder at the Curtis Bay Ordnance Depot nearby was destroyed by spontaneous combustion. Two colored men and a team of mules were standing by the adjoining magazine, 400 feet away, when they heard a hissing sound, suddenly increasing to a noise like the safety valve on a locomotive, and looking around, they saw flames begin to spurt out of the doomed building. They started to run, but the terrific heat overtook them, and blistered the backs of their necks, so that they fell to the ground; fortunately they fell into a slight depression, so that the worst of the heat then passed over them, and they were not seriously hurt. The mules simply trotted around the corner of the building, so that they were in a shadow which cut off the intense heat. The two men had placed their lunch in paper bags, on the ground, and had hung their coats on a couple of spades leaning against the side of the building where they were standing, which, as mentioned above, was 400 feet from the fire. The lunch bags and the coats were burned up, and the shovel handles were charred.

An aviator, flying across the nearby town at an altitude of 2000 feet, saw a yellow tower of flame rise to a height that he estimated as 2000 feet higher than he was flying, then slowly die down. The metal siding and roof sheets of the magazine whirled high in the yellow flame, like leaves in an autumn wind; a fountain of powder cans sky-rocketed around. All this lasted a few brief but exciting seconds, and everything was over. There was no explosion; no noise except a loud roaring sound, like escaping steam. There were no casualties. People in the nearby city did not know that there had been a fire until they read it in the papers.

That is a typical smokeless powder fire, or "flare." There is no explosion; simply a fire, of extremely short duration, and accompanied by almost unbelievably intense heat. But if that had been black powder, it would have gone off with a bang, and would have levelled every building within hundreds of feet in every direction. For that reason, black powder is always stored in very small lots, in small huts, well separated, and no such explosion with black powder can happen, simply because it is so dangerous that no large quantity of it is ever collected together at one time. Great care is exercised in the protection of the public in such matters, and neither high explosives or black powder are ever stored in dangerous quantities in the vicinity of a city.

It may surprise some of our readers to note that we infer above that black powder is more dangerous than smokeless; but contrary to the general impression, black powder is one of the most dangerous explosives to manufacture, store, or handle. It will explode from the slightest spark, and very often a slight friction, or some apparently insignificant cause may produce enough of a spark to cause an explosion. Black powder will ignite at a temperature of 572° F., and when it does ignite in any great quantity, it explodes with great violence, whether it is confined or not, instead of merely burning, as is the case with smokeless powder.

It is, nevertheless, true that black powder is much safer for the experimenter to use in reloading than is smokeless, and that burst or damaged firearms more often result from the use of smokeless than of black. This is because the smokeless powders are potentially much stronger than the black powder. If a strong vessel should be filled entirely full of black powder, and the powder should then be ignited, the maximum pressure that would result, even if the vessel were strong enough to confine all the gas into the original space occupied by the powder charge, is about 86,000 pounds per square inch. This has been tried experimentally. Guncotton, nitroglycerine, and other high explosives, as well as smokeless powder, are all too strong for such an experiment, but calculations indicate that they would under such conditions, give pressures in general a little over four times as great as those given by black powder, or say around 360,000 pounds per square inch; and fulminate of mercury, which is even stronger, would give nearly five times as much pressure as black powder, about 412,000 pounds per square inch.

This explains very clearly why smokeless powder is potentially more dangerous in guns than is black powder; and a very practical reason why greater care must be used in loading smokeless than in loading black powder is the fact that a small change in the original pressure, such as would be caused by reducing the air-space in a cartridge, may, in the case of smokeless powder, change the whole character of the burning of the powder to something like a detonation. On the other hand, nothing like this can occur with black powder, which burns in just the same way whether it is compressed or loose, or even if a double charge is used or two bullets are put in the gun.

It is well for the legal authorities to realize that ordinary smokeless rifle powder, such as is used by rifle club members and others for reloading cartridges, is not the type of explosive that can be used to blow things up. A misapprehension on this score has caused much unnecessary commotion among the police and others at times. For example, shortly after the liner Morro Castle caught fire and burned at sea there was much talk of sabotage, plot, etc., and a few days later the papers reported a case of a man who had been detected taking a small package of rifle powder on board a ship, no doubt to send it to some friend who wanted to reload cartridges. A great hue and cry was raised for a few days, and the public was led to believe that a serious plot had been discovered just in time; but the facts are that smokeless powder of this type will not produce an explosion unless it is strongly confined. It would be practically impossible to use this powder in any way so as to damage the ship structurally, though of course if the powder had been ignited in the can it would make a small, weak explosion of sorts. The only real danger would be that the material is highly inflammable the same as celluloid is, and carrying a one pound can of smokeless rifle powder on a ship is just about as dangerous as carrying a package containing a few dozen celluloid hair combs. Carrying this powder on a ship would not be half as dangerous as taking aboard a quart of gasoline.

Of course, when powder of this kind burns in very large quantities terrific heat is generated, accompanied by the evolution of tremendous quantities of gas, and if many hundred of pounds of powder were burned on board a ship the hull might be pushed open, decks blown up in the air, etc., by the evolution of such great quantities of gas in a short time. In this connection it is interesting to recall what happened on the battleship "Liberte." Both this battleship and the "Jena" of the French navy were destroyed some years ago by the spontaneous combustion of smokeless powder. At that time smokeless powder was relatively new, and the particular type used by France turned out to be quite susceptible to spontaneous combustion due to deterioration. The author was more than usually interested in reading the details of the destruction of the "Liberte" because he had been a visitor on that ship a short time before, and had been very pleasantly entertained by the ward room officers, many of whom were killed in this disaster.

The ship carried approximately 275,000 pounds of smokeless powder, besides the usual high explosive shells, gun cotton for torpedoes and the various other such materials that a battleship has on board. At 5.50 in the afternoon of the day of the disaster the magazines were observed to be on fire, and yellow flames from the burning of smokeless powder spurted from the magazines and ammunition hoists. Several small explosions occurred at this time but it was fully twenty minutes later, *i. e.,* at ten minutes past six, when the very great elevation of temperature and pressure finally resulted in the terrific explosion which destroyed the ship. Most likely this final explosion was due to the detonation of a magazine full of high explosive shells, rather than the action of the smokeless powder alone.

This incident illustrates very clearly the difference between the action of smokeless powder and that of black powder, for if these magazines had been filled with black powder, the whole ship would have been blown to pieces at the first spark; the black powder would have gone off all at one instant instead of burning for twenty minutes before the final explosion occurred.

Primers, Detonators and Initiators

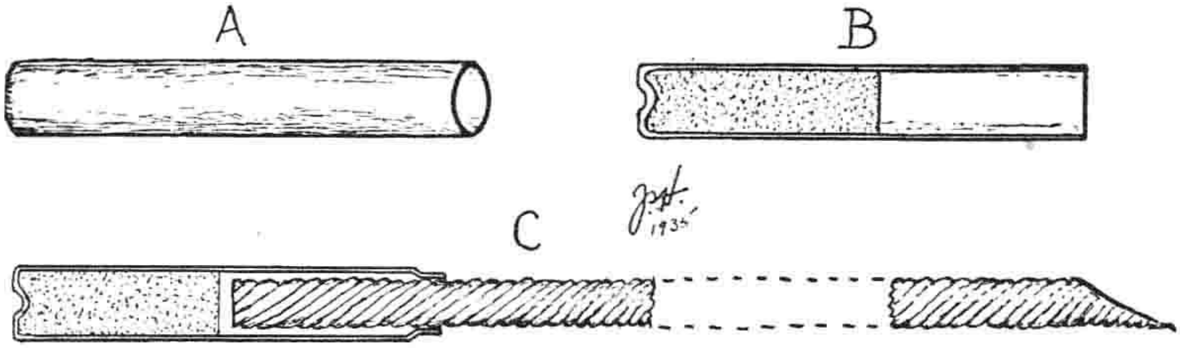
There is still another class of explosives besides the propellants and high explosives previously described. This other class embraces the substances used to ignite the gunpowder in the cartridge, called *primers;* and those used to cause high explosives to detonate, called *detonators.* Together, these explosives are called *initiators.*

Any priming compound requires, as one of its principal ingredients, some substance that is sensitive to friction or percussion; in other words, something that will explode when it is mashed by the blow of the firing pin. Chlorate of potash, when powdered and mixed with a fuel, such as, for example, antimony sulphide, acts in this way; another substance that is extremely sensitive to percussion is fulminate of mercury, which is made by dissolving mercury in nitric acid and then pouring the mixture into alcohol, and afterward collecting the crystals which precipitate out. An old standard priming compound consists of fulminate of mercury, chlorate of potash, and antimony sulphide.

Fulminate of mercury is one of the most sudden and "brusque" of explosives, and has the quality of causing the detonation of relatively insensitive explosives, such as T.N.T., when it is exploded in contact with them. For this reason, it is a favorite detonator. Another one is lead azide, which is similar in its qualities to fulminate, but has the added dangerous quality of exploding just as well when wet as when dry.

Dynamite, T.N.T., and most other high explosives do not explode when ignited; in small quantities, they will burn quietly, and in some cases, with relative difficulty. They are always used by detonating them by means of a dynamite cap, or by a detonator of fulminate or of lead azide, or of some other such compound. A dynamite cap, or blasting cap, is nothing more than a copper capsule filled with fulminate; in other words, a detonator.

These caps are extremely dangerous, for they will explode from any moderate abuse, and when they do explode, they go off with extreme violence. A common item in the daily papers is, "boy pounds blasting cap, loses fingers." Blasting caps are made of copper, cylindrical in shape, somewhat smaller in diameter than a lead pencil, and from an inch to two inches, more or less, in length. If you find any such object as this, act with extreme caution. Unless you know exactly what it is, do not handle it anymore than absolutely necessary to put it where it can do no harm, as at the bottom of a deep river. Even the man who knows the danger is not immune. On May 1, 1934, Captain Clarence O'Leary, Ordnance Department, U.S.A., an expert on explosives, and the author of the Safety Manual for handling them, was investigating the theft of some small-arms ammunition, and alone at the time, was searching in a magazine area on a large Army Post. Chancing upon a culvert, he noticed a piece of metal protruding from the earth. He pulled it out with a stick, and started to rub the mud off of it preparatory to examining it, when it exploded, tearing away his fingers, and inflicting severe wounds on his chest, abdomen and face. With iron nerve, he walked 100 yards to his parked automobile, managed to start it, and alone and injured as he was, drove approximately a mile to the Post Hospital. On arriving there, he walked to the door, and was carried to the operating room. He died four days later. The object that caused this accident was a bomb fuze detonator, that had lain in the mud since the time, ten years previously, when some defective ammunition had been destroyed there.



A. Number 6 Blasting Cap, full size. B. Cross section of same. C. Blasting cap crimped onto a length of safety fuze. Note that inner end of fuze must be cut square across, while distant end may be split or cut on a slant as shown for ease of lighting if desired. Fuze burns usually at either 30 seconds or 45 seconds per foot.

Again, an ammunition maker was examining a war-time explosive bullet found among the captured ammunition brought home from Europe after the World War. It was found to contain a copper capsule filled with a grayish powder, believed to be a fulminate composition. He dropped this capsule into water, and left it there until all the material appeared to have been dissolved out of it; he then looked inside and finding it apparently empty, he stuck a wire inside to measure the depth. Instantly an explosion followed, with a noise like that of a pistol shot; fortunately the capsule was empty at the time, except for a slight residue which adhered to the bottom when the remainder was dissolved out, but even this small amount was sufficient to cause a startling report, though the capsule was not ruptured, and the only damage was an insignificant burn on the fingers.

A vital point and one which cannot be emphasized too greatly in regard to blasting caps and detonators is that they are intended solely to be used to set off a much larger explosion of some substance which detonates. The caps themselves are very much more sensitive than these explosives that they are intended to detonate. Therefore, it is one of the universal rules of safety in handling and storing explosives, *never to keep the detonators or blasting caps near the high explosives,* until the moment they are put together to produce the explosion. They should not be stored in the same room, nor should they be handled or transported together. The particular lesson in this statement is intended for those members of the police who may not have had an opportunity to learn about the safety precautions required with such materials, but who very naturally might, in connection with an arrest of bomb makers, or seizure of an illegal stock of explosives, very innocently carry all the components involved, together in one conveyance to one place of storage. At least two such cases of mixing loose caps and high explosives have come to the personal attention of the author.

The Briscoe Case

The incident that will now be described is very instructive, not only as showing the extreme danger of the blasting cap, but also to illustrate some of the unusual accidents that the firearms or explosives expert will be called on to investigate. The story occupied a considerable amount of space in the newspapers for several days, and extracts from these papers will prove interesting.

Baltimore Evening Sun, Dec. 31, 1934. "WOMAN KILLED IN LANVALE ST. MYSTERY." Miss Katherine Briscoe, 51 year old sister of City Councilman Philander C. Briscoe, today was fatally injured in the cellar of her home at 209 West Lanvale Street—apparently struck in the chest by a bullet. She died a few minutes later. Members of her family said she had gone to the cellar * * * to put some coal on the furnace fire. A few moments later she staggered up the cellar stairs, called her brother * * * Clutching a wound in her chest she gasped that she had been hurt. Her brother * * * telephoned for a physician, who upon arrival found Miss Briscoe dead. * * * Neither the coroner nor the physician were able to determine the exact nature of her injury.

Washington Times, Jan. 1, 1935. * * * Police today advanced the theory that the woman may have been the victim of an unusual explosion of a bullet in the furnace * * * A careful search of the cellar failed to reveal any kind of weapon from which the piece of lead could have been fired. * * *

Washington Herald, Jan. 1, 1935. * * * At first it was thought that Miss Briscoe had been slain by an exploding bullet which had found its way into the furnace. * * * The fire in the furnace was extinguished, and for five hours detectives and policemen screened every bit of ash to find the empty shell of the supposed "bullet." No empty shell was found. * * *

Baltimore Sun, Jan. 2, 1935. A coal miner's detonating cap probably killed Miss Katherine Briscoe, according to Dr. Robert W. Wood, ballistics and scientific expert, who became identified unofficially yesterday with the case that has been baffling the Baltimore police since Wednesday. * * * The doctor branded as absurd the theory of Capt. Nicholas B. Gatch, of the Northwestern District, that Miss Briscoe had been the victim of a coal gas explosion that propelled a bit of waste metal into her body. He gave his opinion that Lieut. Michael Mc. Kew's theory of a souvenir bullet that found its way into the coal bin and consequently into the blazing stove was plausible, but not probable. Lieut. Mc. Kew based his theory, it was reported yesterday, on the fact that Miss Briscoe kept a number of cartridges as souvenirs in a small tray on her desk. While he said he knew little of mining practice, Dr. Wood declared he believed the detonating cap theory was the most probable. Such a contrivance, he explained, could have been mixed up in almost any delivery of coal, and would have power enough to drive part of the metal container with tremendous force * * *.

At this stage of the investigation, the author was communicated with by telephone and asked if he would like to investigate the case. He at once replied in the affirmative, and just before noon on Jan. 3, 1935, accompanied by Lieut. H. Lawrence Gau, Ordnance Reserve, Explosives Expert, he interviewed Mr. Briscoe and Miss Briscoe's brother-in-law, Admiral Pye. As a result of this interview, the author and Lieut. Gau decided to examine the furnace, and to search the ashes, in spite of the fact that they had already been thoroughly searched and screened, as was reported in the press. They therefore proceeded to the Briscoe home, and on looking at the pile of ashes which had been removed from the furnace, almost at once observed lying among the clinkers, a hank of charred insulated wire, obviously the wiring of an electric blasting cap. This find of course definitely cleared up any remaining doubts as to what had happened. Note that "for five hours detectives and policemen screened every bit of ash," yet they found nothing; though the clue to the solution of the whole mystery was before them all the time, plainly visible among the clinkers. The trouble was simply that it requires an explosives expert to know what to look for in such a case. The sequel is given in the next day's papers as follows:

Baltimore News, Jan. 5, 1935. The official report by scientists which ripped away the veil of mystery which has surrounded the tragic death of Miss Kate Briscoe, telling how she by the explosion of a detonator, was handed to state's attorney J. Bernard Wells today. The report was made by Dr. Howard Maldeis, city autopsy physician, Dr. W. B. D. Penniman, city chemist, and Dr. Robert W. Wood, professor of experimental physics at Johns Hopkins University. It revealed that two Army Officers * * * had searched the ashes of the furnace of the Briscoe home, 209 W. Lanvale St., for the second time, and had found the rest of the detonator, of the type used in mines, which killed Miss Briscoe. Following is the report, in part: "It seems that Miss Briscoe went to her cellar to inspect some trunks in storage there, and incidentally placed some soft coal on the furnace fire. An explosion must have taken place, and a fragment of metal, brass or copper, was projected with such force that it penetrated the breastbone, muscular tissue, etc., of Miss Briscoe, and entering the lung, perforated the pulmonary artery, and gave rise to the hemorrhage that caused her death almost immediately. At the autopsy, a small fragment of brass or copper was found by Dr. Maldeis. This small piece of metal evidently originated as part of an explosive casing, and the explosive was one of high power. It was known to all of us that the use of explosive in coal mining is common practice, the charge of blasting powder being set off by a detonator cap containing fulminate of mercury, or some similar material. These detonating caps are electrically fired, and it occasionally happens that one will fail in operation, and so find its way into the coal delivered to the public. The following experiments were carried out:

First—A detonator was placed in a wooden box about two feet high, the detonator, which is about 1½ inches long, being suspended from the top. A hole was pierced through the box at the bottom opposite the detonator, but its fragments could not be found.

Second—A detonator was placed vertically above a piece of yellow pine wood, 1¾ inches thick and about nine inches long. After the explosion a piece of the cap had penetrated the wood about three inches.

Third—A detonator was suspended about one foot above a stoneware jug filled with water, and electrically discharged. The shock of the small piece of material was sufficient to break the jar. A small brass particle was found in the debris, corresponding rather closely in appearance to that obtained from the body of Miss Briscoe.

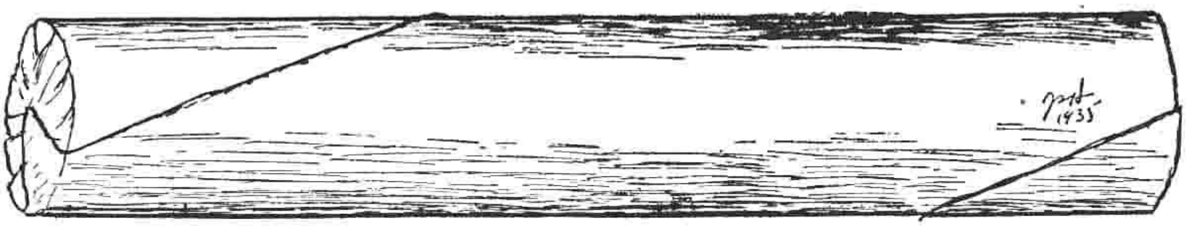
After the above was written, Major Julian S. Hatcher, whose works on the "Identification of Firearms" is well known to experts on the subject, and Lieut. H. Lawrence Gau, researched the ashes from Mr. Briscoe's furnace, and delivered to Dr. Penniman a bunch of copper wire on which the insulation remains in part. These experts, who are United States Army Officers of the Baltimore Ordnance District, have thus produced important evidence confirming our opinion as expressed above. The size of the wire and the character of the insulating material have been compared with that of other detonators, and found to be similar."

The conclusion to be drawn from these incidents is that any red copper capsule that may conceivably have anything to do with explosives should be regarded with extreme suspicion, and should not be handled except by those who know exactly what they are doing.

CHARACTERISTICS OF THE DIFFERENT EXPLOSIVES. ACCIDENTS

It is highly useful for the firearms expert to be well informed on explosives in general as well as on ammunition in particular. It is essential for him to be able to tell black powder from smokeless; to be able to tell from looking at a fired shell or a recovered bullet whether black or smokeless powder was used; and to know, from an examination of a fired gun that has not yet been cleaned, whether the last shot was fired with smokeless or with black powder.

It is also extremely desirable for the firearms expert to know as much as possible about how the different explosives act, and in particular to avoid several of the more common fallacies and false beliefs that are current; otherwise he runs the risk of making inaccurate statements that may be used to his detriment by smart counsel for the opposing side. In addition he should learn as much as he can about accidents with the different explosives. These matters will therefore be discussed briefly in this place.



A stick of dynamite or "cartridge," as it is called in explosives parlance. A common size is 1¼ inches in diameter and 8 inches long.

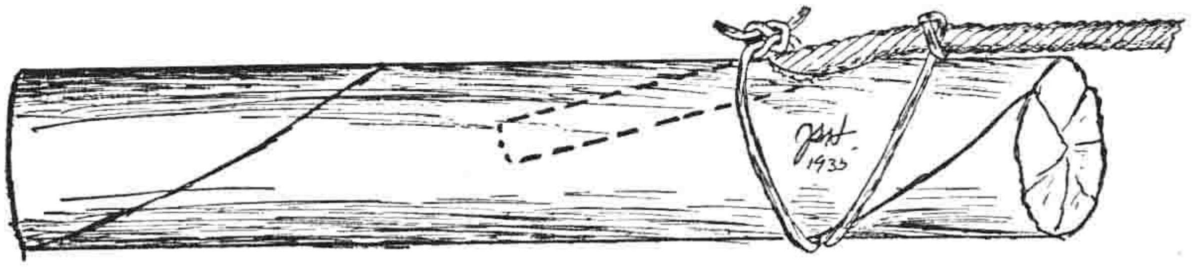
Dynamite

As was stated before, this is essentially nitroglycerin absorbed in some porous material, such as sawdust or porous earth, (kieselguhr). It is a pasty mass, about the consistency of putty, dirty brownish in color, and oily in appearance. It comes in the form of sticks wrapped in waterproof paper. These sticks vary in size, according to manufacture and the purpose for which intended, but are generally about an inch to an inch and a quarter in diameter, and six to eight inches long.

Dynamite is sensitive to shock, but is not nearly as dangerous in this respect as is its main ingredient, nitroglycerin. Therefore, anything that causes the nitroglycerin to separate out will increase the danger. This is the reason for the well-known danger of thawing frozen dynamite, for if this operation is performed too fast, there is a tendency to stew out the "soup," as it is sometimes called, and cause an explosion.

Dynamite is exploded by detonating it with a fulminate cap. It cannot be detonated by setting fire to it, for if it is ignited in small quantities, it will burn quietly, with a dull smoky flame. However, if burned in large quantities, it becomes dangerous from the exudation of the nitroglycerin, which will finally detonate from the shock and agitation, popping and crackling, etc., usually accompanying a fire of any size.

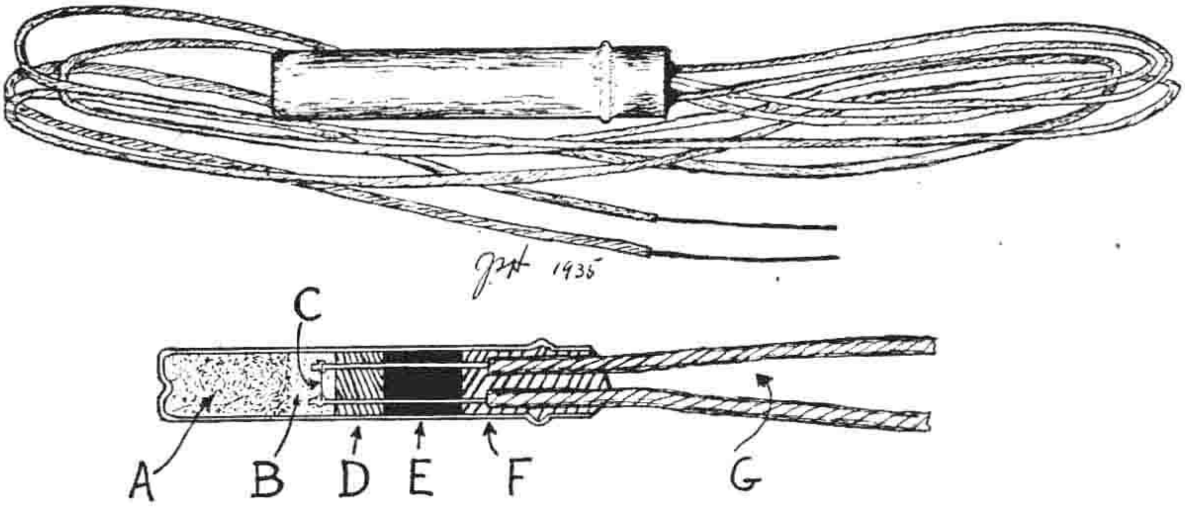
To use dynamite for blasting, the fulminate blasting cap is crimped onto a piece of slow-burning fuze, known as Bickford fuze, as illustrated in the sketch on page 118. A sufficient length of this fuze is provided, and the cap is crimped onto one end of it, and then embedded into one of the sticks of dynamite using a pointed wooden stick or "skewer" for this purpose. The other end of the fuze is lighted, and while it is burning slowly toward the cap, the operator removes himself to a safe place. When the flame finally reaches the cap, it explodes, and the resulting shock detonates the dynamite.



Blasting cap, with fuze attached, imbedded in a stick of dynamite ready for inserting in position for firing. When several sticks are to be fired at once, only one has a cap in it, and this one is called the "Primer."

It is well to realize that there are several different kinds of fuze, burning with different speeds, and the user should always make sure how fast the fuze will burn before using it, else he may not allow enough time between the application of the match and the explosion. In particular, there is a type of fuze known as Instantaneous Fuze, that burns with great rapidity, and serious results might follow the mistaken use of it in place of regular safety fuze, for the explosion would occur at sensibly the same instant that the match was applied to the end of the fuze.

Besides using fuze which is lighted with a match to explode the dynamite cap, there is another method which is universally used in commercial blasting, and that is the electrical method. The dynamite cap for electric blasting has two little wires coming out of it. These are twisted on to the ends of a long double strand of insulated wire which leads to a distance sufficient for safety. Before connecting the cap on to the wires it is imbedded in the dynamite, making a suitable hole in the dynamite by the use of a soft wood plug pointed at one end, called a skewer. The operator then places the dynamite in the position desired, after which he goes to the other end of the wire which he connects to a blasting magneto. This is a small box containing a little dynamo which is arranged so that the armature is spun rapidly when a handle on top of the machine is pushed down. There are some terminals on the outside for connecting the wire. After the wires are properly connected, the handle on top of the machine is raised up as far as it will go, and then when it is desired to fire the dynamite the handle is pushed down as quickly as possible. This downward motion of the handle spins the armature of the magneto thus generating the current of electricity which fires the cap.



Top. Electric blasting cap, complete. Bottom. Section of electric blasting cap. A. Compressed explosive. B. Loose explosive. C. Bridge wire which heats when current is applied and so fires the cap. D. Sulphur and asphalt. E. Asphalt. F Sulphur. G. Lead-in wires.

Instead of using the magneto blasting machine as described above, the dynamite can be fired by using batteries. After the dynamite is all prepared as described above the operator goes to the distant end of the wire and touches one of the two ends to one terminal of the battery and the other end to the other terminal. This completes the circuit and fires the dynamite.

Another device for the ignition of explosives, which looks much like an electric cap in general appearance, but acts in a very different manner is the electric squib, which is used to ignite blasting powder. This is a small tube similar in size to a dynamite cap, hollow at one end, and containing a pair of wires projecting from the other end. When the two wires are connected to the double conductor, and then the blasting magneto is used the electricity ignites a small charge of powder inside the squib and causes a flame to shoot out the open end. This device can thus be used to explode gun powder or blasting powder which goes off by simply being ignited, and does not need any shock like the explosion of a cap to set it off.

The following incident illustrates how these electric squibs may sometimes be used to ignite the fuze that explodes the cap that detonates a high explosive. Once the author had occasion to destroy a number of dud artillery shells which were too dangerous to be moved and he did this as is usual, by placing blocks of TNT against the fuze of the dud shell and then exploding the TNT, which caused the consequent explosion of the shell. The only blasting caps available were some No. 6 electric caps and some stronger ordinary caps. The electric caps proved too weak to detonate the TNT, they only blew it to pieces without making it go off. It was necessary therefore to use the caps which required a fuze. However it was much preferred to use the magneto blasting machine, and thus know exactly when the explosion was going to take place, therefore a short piece of instantaneous fuze was crimped into the strong blasting cap; then an electric squib was wired and slipped over the end of instantaneous fuze. Then when the handle of the blasting machine was pushed down, the squib fired the instantaneous fuze and this in turn fired the cap which detonated the TNT and destroyed the shell all at the same instant. This was much more satisfactory than lighting a piece of ordinary fuze and then waiting for the explosion to occur. This is especially true in destroying gas shell where we could take advantage of moments when the wind was blowing directly away and then press down the handle of the magneto with the knowledge that the shell would be blown up instantly.

Dynamite detonates with extreme suddenness, or "brusqueness" as it is called in explosives parlance. For this reason, when it is exploded in contact with a rock or any similar substance, it will often have a powerful effect, even when it is not "capped" with mud or dirt, or tamped in any way. On the other hand, blasting powder, when exploded under the same conditions, will have little or no effect unless it is well tamped, for it is relatively slow in its action, and unless there is something in the way, the gas will escape without doing much damage. This difference in the action of dynamite and of slower explosives has given rise to the erroneous impression, often quoted, that "dynamite always acts downward." There is absolutely nothing in this. If laid on top of a rock, dynamite acts downward; if laid on the side of a rock, it acts sideways; if fastened to the under surface, it acts upwards. In other words, if it is placed in simple contact with any surface, it acts on that surface, because it explodes with such suddenness that the air all around it does not have time to move, and thus acts as a mild tamping. Of course, if dynamite is tamped, it acts more energetically, and if it is covered, the explosion will exert its greatest effect in the direction of the least resistance.

In newspaper accounts and other such places a profound ignorance of explosives is often revealed in the exaggerated ideas of the effects that a small amount of explosives will have. For instance, we often see an item such as the following "When arrested, the suspect had with him a suitcase containing enough dynamite to wreck several city blocks." This is ridiculous on the the face of it. A suitcase full of dynamite would surely do enough damage if it were exploded in a crowd, as was the Wall Street bomb of a few years ago; but it would not wreck even one good sized office building, let alone a city block. Of course, it would blow all the windows out of the front of a building; or it might start a fire that would wreck the building; but the actual structural damage that even a suitcase full of dynamite would do to a modern steel-framed office building is small. One stick of dynamite, when used properly, will cut a steel railroad rail, and one stick will blow a hole perhaps two feet in diameter in a good strong brick wall; but that is about all.

When a very large quantity of dynamite explodes at one time, the results naturally are spectacular. One of the largest recorded dynamite explosions occurred near the place where this is being written when the steamer "Alum Chine," loaded with dynamite, exploded in the lower harbor of Baltimore on November 7, 1913. The ship was not allowed to come into the inner harbor, as the regulations forbid the unloading of explosives there, which was a very wise provision, as the subsequent events showed. The steamer, carrying a full cargo of dynamite, was being unloaded onto barges, with the aid of two tugboats, when in some unknown manner a detonation occurred, which involved all the dynamite on the ship and on the barge which was alongside. The steamer, the two tugboats, and the barge were instantly demolished, with the loss of about 60 lives, as every person on any of the vessels involved was killed by the terrific blast. Peculiarly enough, the concussion was felt much more severely at several distant points than it was in nearby Baltimore, where no very great damage was done. Somewhat surprisingly, the hull of the Alum Chine was not blown to bits, as might have been expected, but held together essentially in one mass, with the result that a costly job of clearing the harbor was involved.

Tri-Nitro-Toluol or T.N.T.

This is a yellowish substance, somewhat resembling sulphur in appearance, though it is not quite as bright in color. Also like sulphur, it can be melted and moulded into any desired shape. T.N.T. or a similar explosive, Tetryl, is often seen in the form of demolition blocks used by the Army Engineers. These blocks are made of melted explosive, moulded to form and afterward copper-plated, so that they look very much like solid blocks of copper, about two inches square and four inches long, with a hole in one end just large enough to receive a blasting cap. To explode one of these blocks, a cap is crimped onto the end of a piece of fuze, and then inserted into the hole in the end of the block. The block is placed in the desired position, the fuze lighted, and the operator leaves the vicinity until after the explosion occurs. Or, more conveniently, an electric cap is used, in connection with the magneto blasting machine.

T.N.T. is so relatively insensitive that a good strong cap is required; if a weak one is used, it may simply pulverize the block of T.N.T. without making it explode. T.N.T. is a very strong explosive, but at the same time a very safe one to handle, as it is so extremely insensitive to shock that a rifle bullet can be fired into it without causing detonation; and it can be burned in small quantities without danger of explosion. However, if burned in very large quantities, it has been known to explode after the fire has assumed very large proportions and the heat has become very intense. Probably the long exposure to extreme temperatures during a big fire may change a part of the mass into some other compound that is more sensitive than the ordinary T.N.T., and the great heat and pressure, coupled with the agitation, crackling, boiling rumbling, etc., accompanying the conflagration, may cause some of these sensitive compounds finally to detonate, and thus start the mass.

For years it was thought by authorities on explosive that T.N.T. could not be detonated under any circumstances merely by burning, as has been described above; but at least two disastrous explosions have occurred as a result of T.N.T. fires. The first was the explosion on December 6, 1917, of a munitions ship loaded with T.N.T. in the harbor of Halifax, as the result of fire following a collision. There were said to have been some drums of gasoline on the fore deck, while the hold was full of T.N.T. The gasoline took fire as a result of the collision, and the flames got beyond control, and spread to the T.N.T. in the hold. The crew left in small boats, and rowed away as fast as they could About twenty minutes later, the whole shipload of T.N.T. detonated, laying about one third of the city in ruin and killing 1226 persons outright, with 400 others missing.

The largest explosion on record occurred on July 10, 1926, at the Naval Ammunition Depot, Lake Denmark, N. J., as a result of a fire following a stroke of lightning. The building struck contained an enormous quantity of T.N.T., and this took fire After burning fiercely for about 20 minutes, the building detonated, with an appalling loss of life and property; a few minutes later, a second building, containing six million pounds of T.N.T. also detonated. These two initial explosions were followed at intervals by many others, as fires were started in many parts of the depot, and one building after another burned and blew up The property loss was about $85,000,000. The author was fortunate enough to be able to visit the scene of the explosion immediately after it occurred, and, in fact, before the secondary fires had died out.

The layman invariably speaks of any major disaster occurring from explosives as an "explosion," but the professional powderman has a definite term for referring to the different types; thus he would speak of a smokeless powder fire as a "flare," a black powder explosion as a "blow" and a dynamite explosion as a "blast."

Accidents With Ammunition

Small arms ammunition, in the form of cartridges, is not likely to be the cause of an accident, for it is very difficult to make it explode unless it is in a gun; moreover, ammunition, especially when it is loaded with smokeless powder, does not explode with much violence unless it is confined in the chamber of a weapon.

The only way to set off a cartridge not in a gun is to heat the cartridge, or to strike the primer just right. If cartridges are burned in an open fire, the cartridge case will be ruptured by the pressure of the burning powder inside, and at that instant the pressure will all escape, without projecting the bullet with any great velocity, as most people mistakenly suppose it will. The greatest danger in such a case is from flying particles of brass, which might endanger the eyesight. For this reason, the practical joker who threw a whole bandolier of rifle cartridges into a campfire, and then stood there grinning at people who were frightened enough to run did not show very good judgment, even though all that happened was the scattering of the embers to the accompaniment of a popping like that made by a string of firecrackers.

Recently a child sitting on the floor by a fireplace had both eyes put out by the explosion of a cartridge that had been swept into the fire by accident. But of course the child had its face right by the fire, and it is no wonder that trouble resulted.

Working with military machine guns, which sometimes jam when they are red-hot, will furnish many opportunities for observation of what a cartridge will do when exploded from the heat. The author, who for years was in charge of various machine gun testing and development work in the army has been able to make some interesting observations along this line. Once, on the Mexican border before the World War, he attempted to clear a hot gun, which had jammed with the breech half open, by pushing the live cartridge out with a ramrod inserted in the muzzle. Just as the rod touched the bullet, the cartridge exploded from the heat. As the breech was open, the cartridge case blew out at the back, and the bullet, resting against the rod, did not move. Again, while the author was lying behind a hot gun, a cartridge extracted from it exploded as it struck the ground not over 18 inches from his face. At a test of machine guns, a live cartridge ejected from a hot gun exploded in the air, and the bullet stuck in the starched cuff of a spectator standing by the side of the gun.

Rough handling can also explode cartridges outside of the gun. A girl working in the cartridge factory was shoveling .45 pistol cartridges out of a bin with a wooden scoop. One of them exploded, and the empty case struck the girl in the left breast, inflicting a slight cut in the skin. Various cases such as this have been known, and in none of them was there any serious injury.

It should be quite evident from the statements made above, that there is no great danger from cartridges, if, for example, there is a fire involving a hardware store where a moderate quantity of ammunition is stored.

Bombs

The way the assassin generally uses an explosive is in the form of a bomb; that is, some stout metal container which will be blown to bits by the explosive, and which will cause injury or death by flying fragments.

In investigating any such incident, look particularly for any bits of iron, steel, wire, particles of copper cap, etc. Also note carefully the character of the residue, if there is any left, or of the smoke or smudge left by the explosion. A competent explosives chemist can analyze the residue and tell what kind of explosive was used. The officer investigating any such case should take extreme precautions to prevent spectators or curiosity seekers from picking up objects, touching anything, or approaching closely enough to change the appearance of the objects involved.

The following case, reported by Lieut. H. Lawrence Gau, Ordnance Reserve, who was called in as an explosives expert by the Maryland State Police during the investigation, will give an idea of the work in connection with explosives that the expert may be called on to do, as well as the importance of suitable precautions by the local authorities to preserve the evidence until a proper examination can be made. In this instance, both the State police and their expert were much handicapped by a lack of such precautions, as will be seen. Moreover, this case will give the reader a very good idea of the effects of a small quantity of dynamite, for Lieut. Gau estimates that the damage was caused by approximately two sticks of dynamite, or an equivalent amount of some other high explosive, exploded under the left floorboards of the car.

The Kirk Murder Case

On January 7, 1933, Miss Ida Kirk, of Budd's Creek, Maryland, was fatally injured by a mysterious explosion under the floor-boards of her Buick coupe. She had just started the car, and together with another woman as a passenger, had started toward Washington. After she had driven about a mile the explosion occurred.

The condition of the car when it was found was described as follows:

All glass out of both doors, windshield, rear window, and headlights; gasoline tank leaking slightly; right door jammed, left door sitting open; right hand running board and fenders torn loose from body; entire hood missing, and found in a field about forty feet from the road; air cleaner on carburetor hanging loose; steering wheel bent upward, and slightly forward; drive shaft housing bent to the right and slightly upward; forward part of muffler completely demolished; left hand side of chassis immediately under dash was bent outward and downward, and bent again in same condition at a point between clutch pedals and seat; metal tray for tools under seat bent uward in a "V" shape; floor boards completely demolished, and all pieces pointing upwards, with the exception of the extreme right side under dash; rear left tire flat; slight hole in left hand side of radiator inside; left hand running board torn loose from the body.

When the expert arrived, the burn or smudge on the roadway, about four feet square, had been washed off; the metal parts and debris of the explosion had been swept off the road into the weeds on each side and souvenir hunters and curiosity seekers had been allowed to overrun the place and carry off small pieces, etc. Lieut. Gau states that one man had to be threatened with arrest before he would give up a piece of the floor-board of the car that he had taken, and that the expert wanted for examination.

Gas Explosions

Any explosion occurring in this day and time is pretty apt to be blamed on a bomb or some high explosive, and much mystery is frequently wrapped around what is often to prove a purely natural chain of circumstances. But the fact is that a majority of the explosions which occur in small homes throughout the larger cities, and which do not seem to have any cause or reason, can be laid to a spontaneous ignition of some natural, but unusual formation of explosive gases, which have seeped into some part of the building and finally ignited.

In these modern times, there is every possibility that inflammable gases from gasoline, illuminating gas, fuel oil, coal gas from a heater, or even some type of sewer gas, might gradually fill up a basement or other closed room of a building and then explode. The investigator should not be too much inclined to accept some sensational theory to account for an explosion amongst people who have led lawful normal lives, and where no motive for foul play appears.

It is well for the reader to know something of the way that gas explosions act, and the characteristic differences between them and other types. Gas explosions are more likely to be large in volume, and with a decided capacity to exert power on large objects, like floors, walls, partitions, etc.; and they move these things, rather than rending them to pieces as does dynamite or some other high explosive. The high explosive will shatter and rend the things which are near it, while those that are a reasonable distance away will not be injured, unless it be by flying fragments. The gas explosion, on the other hand, will move large objects about, but will not shatter them, and the effect is more generalized than is the intensely local effect of a detonation. Gas explosions are more of a push, distributed over a large area; an explosion of low intensity, but with considerable total power because it covers so much space. The expert will readily distinguish between the wide general effects of a gas explosion and the more intense but localized effects of dynamite or high explosive.

As an example of the effects of a gas explosion, a rather severe blast in the cellar of a small house lifted it from its foundations and turned it slightly, so that it was a foot or more out of position. The detectives were at first inclined to believe that it was a bomb explosion; but an expert pointed out that dynamite would have shattered or blown a hole through the side of the wall without lifting the entire house bodily; and that an explosion that could have lifted the whole house without doing any severe local damage, must have been of low unit intensity yet must have had a considerable total power; in other words, a gas explosion from the furnace was indicated as the probable cause. Investigation showed that this opinion was correct.

Destroying Explosives

If it is necessary for one reason or another to dispose of ammunition or explosives, it is well to know how to do so safely. Black powder is readily destroyed by the action of water, which dissolves out the saltpeter, and thus renders the remaining ingredients harmless. Smokeless powder cannot be disposed of in this way, because it is impervious to water. It is best disposed of by spreading it in very small quantities on the ground and burning it. Fulminate of mercury is dissolved by hydrochloric acid. Small arms primers in bulk are dangerous, they are best destroyed by throwing them into a deep body of water. Cartridges in small quantities may be destroyed by pulling out the bullets, emptying out the powder and destroying it as described above, and then destroying the primer by snapping it in the arm for which the cartridge was intended.

Small collections of individual cartridges may be made entirely safe for handling by cautiously drilling a small hole, (using a sharp drill to avoid heating), in the front part of the powder space and emptying all powder out of the case, then squirting a drop or two of oil into the primer, which destroys its action. However, there is really no reason for taking this extreme precaution.

Hand Grenades, Fuzes, Detonators, Artillery Ammunition, etc., and especially old ammunition or material of this kind which may have been fired and not exploded, ("duds"), should *never* be handled nor should any attempt be made to move or destroy them except by a qualified ordnance expert who knows exactly what the object is, how it is constructed, and what to do with it.

Handling "Duds"

One of the most fruitful causes of personal injuries and deaths among civilians in any area which has been the scene of military operations is the ill-advised disregard of any such caution as has been given in the preceding paragraph. Visitors to the battlefields are usually on the lookout for likely souvenirs, and many times they will pick up the most dangerous possible articles and transport them home, where they may lie for years unnoticed, yet all the time they may be ready at the slightest jar to explode and wreak death and destruction on all in the vicinity.

Of course, the war is long past, but the souvenirs that were brought home afterward are still with us. The unfortunate part of all this is that the danger is thus not limited to a war area, but is present in the most unexpected places, and at any time the police may encounter dangerous war souvenirs in the hands of children on the streets, or in other places. That this danger is not in the least exaggerated will perhaps be apparent from a consideration of the incident which will now be described.

Several years ago, the writer, then Executive Officer of one of our large Government Arsenals, received a telephone call from the police department of the neighboring city, (one of the largest in the country), stating that they had taken an object from some children who were throwing it around in the street, and that it looked like "an Army bomb." Information was requested. As the writer was just then getting ready to start out on a visit which would take him within a few blocks of the Police District Headquarters in question, they were told to hold it for his examination. The object proved to be a defensive hand grenade of the most dangerous type. When first observed, the children were attempting to pull out the "safety pin" which would have allowed the grenade to explode in three seconds, *if* the grenade were loaded and had a live fuze attached. The grenade was in apparently new condition, and no danger was therefore anticipated in unscrewing the fuze, or *bouchon* assembly, to see whether or not it was live and loaded. However, when the writer explained what it was, and that he would unscrew the fuze to see whether it was loaded, the several police officers in the room all made for the door, and the captain, with an anguished cry of "Let me OUT of here," was the first one through. The reader may laugh, but these officers acted with very commendable caution. THE GRENADE WAS FULLY LOADED.

The worst thing about old shells, bombs, fuzes, and all such war souvenirs, is the fact that they may have deteriorated to such an extent that they will explode if they are merely turned over in the gentlest possible manner. The writer knows of a case where a souvenir shell from the Spanish-American War, which had been in a house for years, exploded when it was turned bottom up for the purpose of reading the stamping on the bottom. "Duds," or material that has been fired and has failed to explode, are far more dangerous than unused material, for in the latter there is usually a safety device which remains locked until the shock of firing releases it.

Therefore, if any old war material is found, do not handle it at all unless necessary. If it must be handled to remove it from the reach of children or curious persons, move it as gently as possible, and avoid any sudden jars or shocks. Do not turn it over if it can be avoided; the simple act of turning such an object may cause an explosion. The same precaution applies to anything that appears to be a bomb, or to any package or device that may possibly contain explosives. Any such objects should be handled only by men who know about such things, such as some member of the force who has had experience with explosives and bombs, or a member of the bomb squad, if there is one organized.

CHAPTER 5

FIREARM, CARTRIDGE AND BULLET MARKINGS

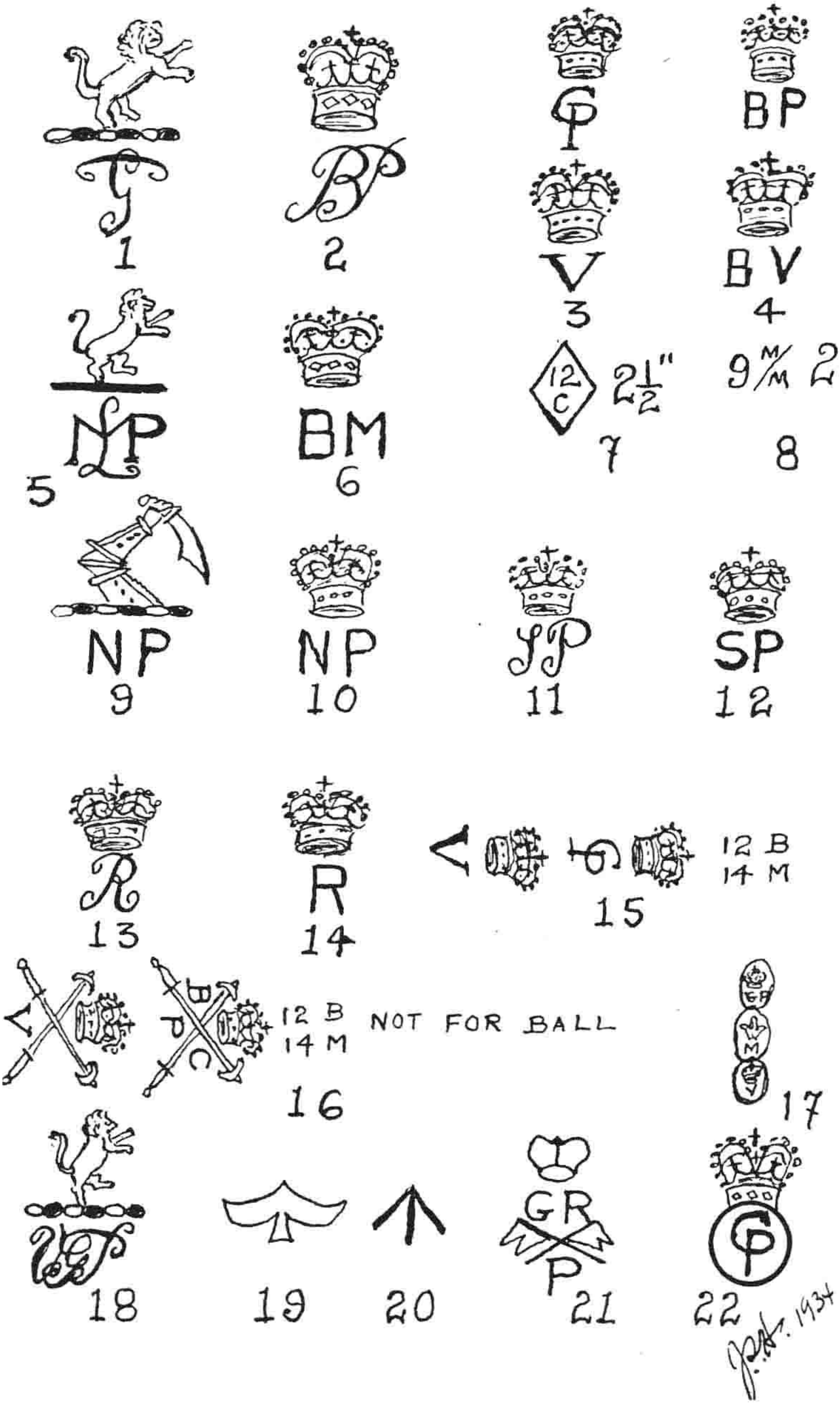
OF extreme importance to the firearms expert is a thorough knowledge of the various trade markings to be found stamped on guns and ammunition. For example, the serial number, carried by all modern firearms, enables the gun to be definitely identified at all times in case of theft, etc., if the serial number has previously been recorded. One of the first things to do when any "evidence gun" is received, is to record the number. This makes the identification of an evidence gun in court much simpler than if no such number were present; for the number should be officially recorded as soon as the gun enters the case, and at any time thereafter it will be known whether or not a gun presented in court is the same one, merely by comparing the number with the record. Moreover, the serial number is extremely important when it becomes desirable to trace the origin of a suspected gun, for the maker can tell what dealer obtained the gun, and the dealer will have a record of the person to whom it was sold.

Serial Numbers

Most modern firearms are marked in a prominent place with the name and caliber of the cartridge for which the gun is intended, and the name of the maker. In many cheap foreign guns, the name of the maker may be omitted, but the caliber designation will practically always appear. In rifles, shotguns, and revolvers, this caliber designation is usually found on the side of the barrel, but in automatic pistols, where the barrel is inside the slide or other part of the gun, the caliber marking will be found in a prominent place. However, these markings do not always appear; the author has before him, as this is being written a well made revolver of a good make which has no markings visible except the trade mark of the maker.

The serial number may appear in any one of several different locations, which vary according to the fancy of the maker. Often

ENGLISH


TG
1
BP
2
GP
V
3
BP
BV
4
NLP
5
BM
6
12 C
2½"
7
9 M/M 2"
8
NP
9
NP
10
SP
11
SP
12
R
13
R
14
V
G
12 B
14 M
15
V
BPC
12 B
14 M
NOT FOR BALL
16
GP
M
V
17
WG
18
19
20
GR
WP
21
GP
22
1934

the serial number on a revolver may be found on the frame under the wooden stocks, which must be removed to find it; other times it is found on the frame behind the crane, so that it is visible only when the cylinder is swung out; again, it may be on the metal part of the frame between the wooden stocks at the bottom of the grip. On automatics the serial number is often found on the side of the frame.

Some very high grade arms, especially the military ones, like the Springfield rifle, are made fully interchangeable, so that when a part breaks or wears out, any other similar part may be put in its place without any fitting. In such cases, the serial number is carried on only one principal part of the gun, which usually is the receiver. But with even the best of guns, it is sometimes difficult to achieve such a high degree of interchangeability, and often some hand fitting is necessary for satisfactory results. When this hand fitting of various parts is done, it is customary to mark each part with the same serial number as that of the original gun. Thus, in most arms nearly every important part will be so marked. With small parts, where there is not room to put on the whole number, the serial number will appear on the frame of the gun, and the small parts will have only the last two or three figures of the number. For example, if the serial number of a Luger Pistol is 1679, the various small parts will each be marked 79. Even in the Springfield rifle, the bolt will often be marked

---

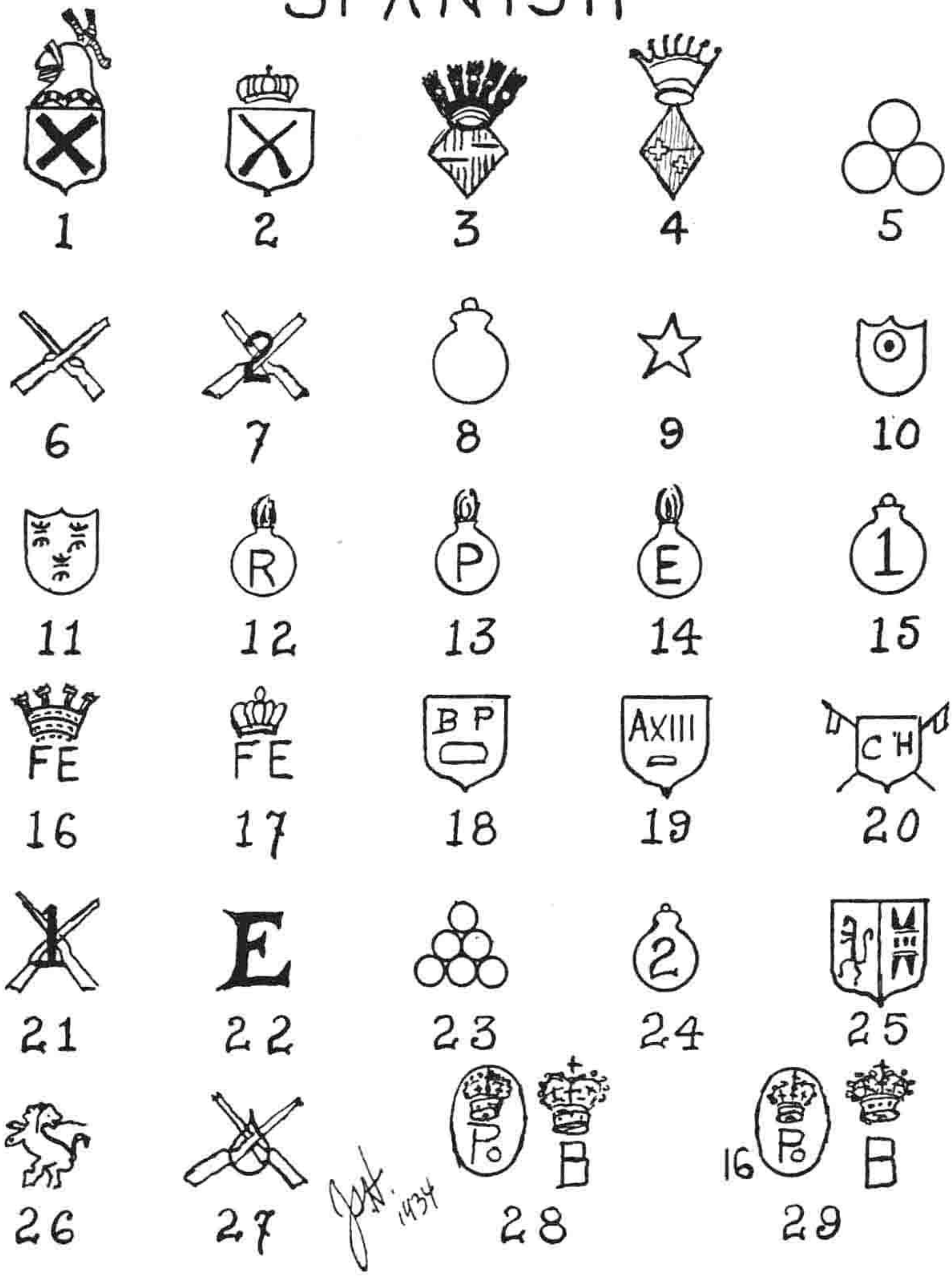
BRITISH PROOF MARKS

1. London Provisional Proof.
2. Birmingham Provisional Proof.
3. London Definitive Proof.
4. Birmingham Definitive Proof.
5. London Mark for special definitive proof of Rifle barrels, Class 10.
6. Birmingham Mark for special definitive proof of Rifle barrels, Class 10.
7. Chamber mark, breech loading shotguns. (Bore and length of cartridge.)
8. Chamber marks, breech loading rifled arms. (Caliber and length of cartridge.)
9. Nitro Proof, London.
10. Nitro Proof, Birmingham.
11. Special Proof, London.
12. Special Proof, Birmingham.
13. Re-proved Arms, London.
14. Re-proved Arms, Birmingham.
15. Choke Bore Mark, London, now obsolete. Upper figure, "12 B" shows gage at breech, lower figure, "14 M" shows gage at muzzle.
16. Choke Bore Mark, Birmingham.
17. An old London Mark, now long obsolete.
18. London Mark employed prior to new rules adopted in 1925.
19. The "Broad Arrow," sign of Government ownership.
20. Another form of the Broad Arrow.
21. Military Proof of rifles and automatic pistols.
22. London Definitive Proof for arms of foreign make. Followed by the words "Not English Make." Marks numbers 1, 2, 3, 4, 5, 6, 9, 10, 11 and 12 are treated in a similar way when applied to arms of foreign make after British proof; consequently all these marks may be seen with the letter or letters enclosed in a circle, and followed by "Not English Make."

with the number of the rifle to which it is fitted, this marking being done with an electric arc after the final fitting.

At the present time, in practically every country the arms manufacturers number all their guns serially by models: but this has not always been the case, for it has not been so long ago that some makers in Germany and elsewhere numbered the guns by orders. If a large dealer ordered, say, 10,000 guns, the first

SPANISH


1
2
3
4
5
6
2
7
8
9
10
11
R
12
P
13
E
14
1
15
FE
16
FE
17
B P
18
AXIII
19
C H
20
1
21
E
22
23
2
24
25
26
27
P° B
28
16 P° B
29

JH. 1934

one would be No. 1, the next No. 2, etc., and then when another large order was received, another series of numbers might be started, duplicating the ones already used in the last order. The possibility of there being two guns of the same serial number thus exists, and should be borne in mind.

In the .45 Caliber Government Model Automatic Pistol, all the guns made by Colt on Government contract are numbered in one series, while those made for sale commercially are marked with another series of numbers preceded by the letter C, thus C146038. In addition, guns of this design were manufactured by Springfield Armory and by the Remington Arms Company, and thus three guns bearing the same number may be found; there is, however, no chance for confusion if the maker's name as well as the serial number is quoted, as it always should be.

Besides the serial number, there are other manufacturer's marks found on most guns. These include the inspector's marks, generally a letter of the alphabet, but sometimes some other mark, symbol or design. When the gun is in the process of manufacture, each part has to be inspected from time to time, and when the part is finished, it must be checked and gauged to see that it agrees with the drawings and specifications, and these inspector's marks are put on all pieces that pass these tests. Usually there are a number of men on this inspection work, and each one has a distinctive stamp, with his initial, or some other designating mark, and when he is satisfied that a piece is correct, he stamps his symbol on it. Thus if there is later a complaint of faulty material, the responsible inspector who allowed the faulty work to get by is known. In addition, when guns are made for the Army or the

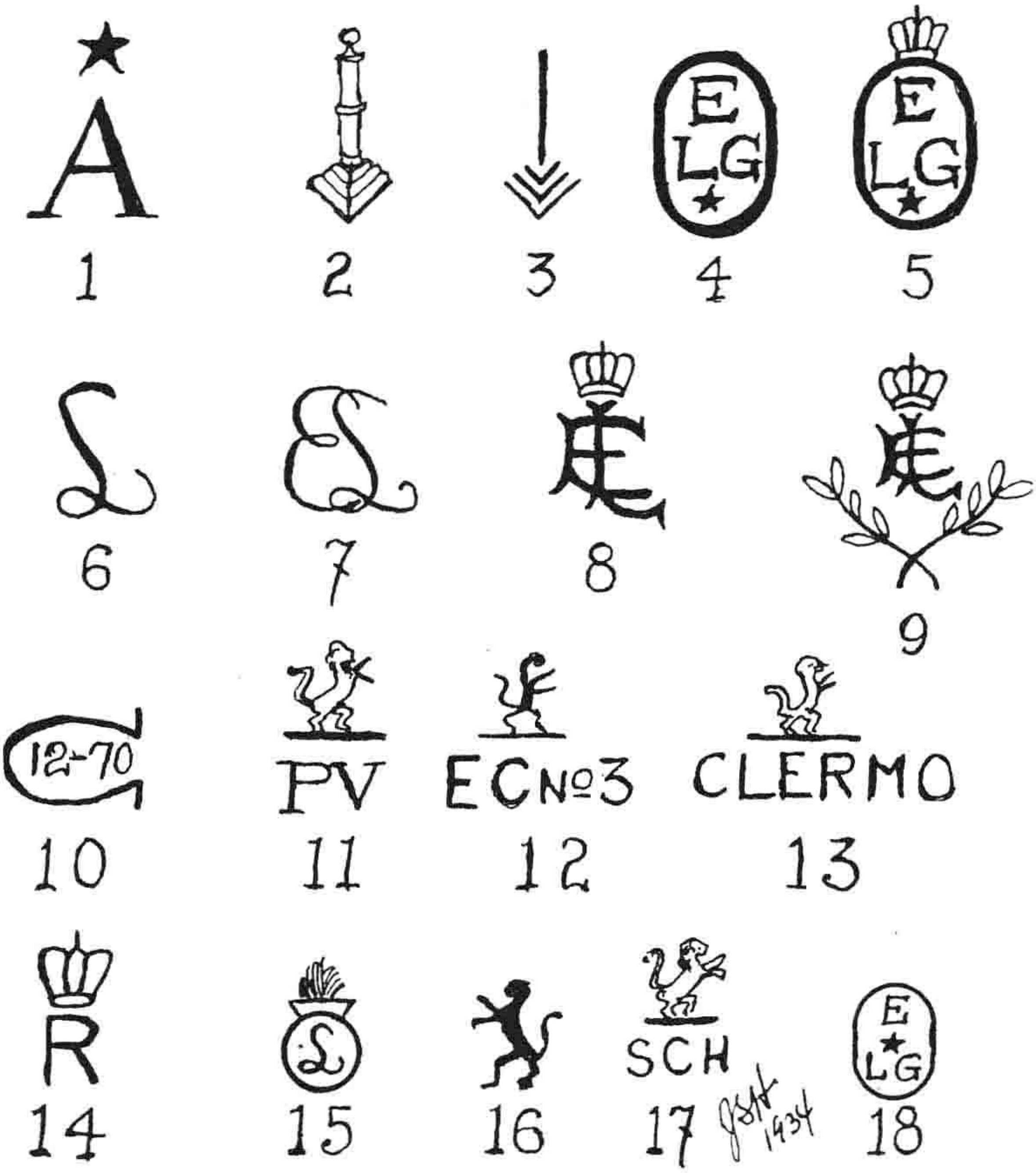
---

SPANISH PROOF MARKS

1. Present Eibar Proof.
2. Old Eibar Proof, under the monarchy.
3. Present Barcelona Proof.
4. Old Barcelona Proof.
5. Definitive Proof for smooth bore muzzle loading arms.
6. Provisional Proof for smooth bore breech loading or automatic guns.
7. Definitive Proof for the smooth bore breech loading or automatic guns.
8. Single Definitive Proof for rifled carbines or muskets.
9. Single Definitive Proof of low power pistols and carbines.
10. Single Definitive Proof of non-automatic pistols.
11. Old form of the mark just described.
12. Definitive Proof of revolvers.
13. Definitive Proof of automatic pistols.
14. Definitive Proof of foreign made arms.
15. Definitive Proof of rifled muzzle loaders.
16. Indication that arms have been inspected and meet the required tolerances.
17. Old form of "View Mark" just described.
18. Supplementary Proof of breech-loading and automatic shotguns.
19. Old form of last described mark.
20. Second supplementary proof of breech-loading automatic shotguns.
21. Single Definitive Proof of breech loading shotguns.
22. Special Proof with excessive overcharge.

23-29. These are old marks now superseded.

BELGIAN


1
2
3
E LG
4
E LG
5
6
7
8
9
12-70
10
PV
11
ECNo3
12
CLERMO
13
R
14
15
16
SCH
17
E LG
18

Navy, the Government Inspector has a distinctive official stamp with which he marks the material that meets the specifications.

In addition, there are marks and stampings indicating Government ownership. The British Government uses the well known symbol of the "Broad Arrow" for this purpose. In America it is customary to mark pistols and revolvers made on Government contract "United States Property." However, legal authorities should not get unduly excited if they find an obsolete model pistol or revolver bearing this mark in the possession of an individual, for the Government has in the past made a practice of selling out-of-date stores bearing this mark, and large quantities of such articles are legitimately in the hands of the public. But if a current service arm, such as the .45 Caliber automatic pistol is found under similar conditions, the possessor should expect to be required to prove his right to have it. A certain number of rifles have been sold to civilian marksmen by the Government under authority of Congress; but in every such case, a bill of sale accompanies the arm, and this should be preserved by the purchaser. If this is not available, the Ordnance Department records in Washington will tell whether or not the arm was sold to an individual.

The importance of this matter is not always sufficiently realized, as the incident described below will make clear. A competitor at one of the big pistol matches was loaned a Government pistol for use in the match, and, as is usual in such cases, was made to put up the price of the gun as security for its return. He applied to be allowed to purchase it, but it is not the present policy of the Government to sell pistols to individuals, even though the sale of arms to members of the National Rifle Association is permitted by law. But he wanted the gun, so when the match was over, he reported that he had lost it, and as a result he forfeited his collateral, and considered that he had thus paid for the gun, and that it was his property. But some months later, in Alaska, he was seen to be in possession of a pistol marked United States Property, and was asked to explain. He stated that he had bought the gun, but as he could not produce any bill of sale, he was held while the War Department was communicated with. The report was that the gun in question had been reported missing at the National Matches, and presumably was stolen. The possessor was at once

---

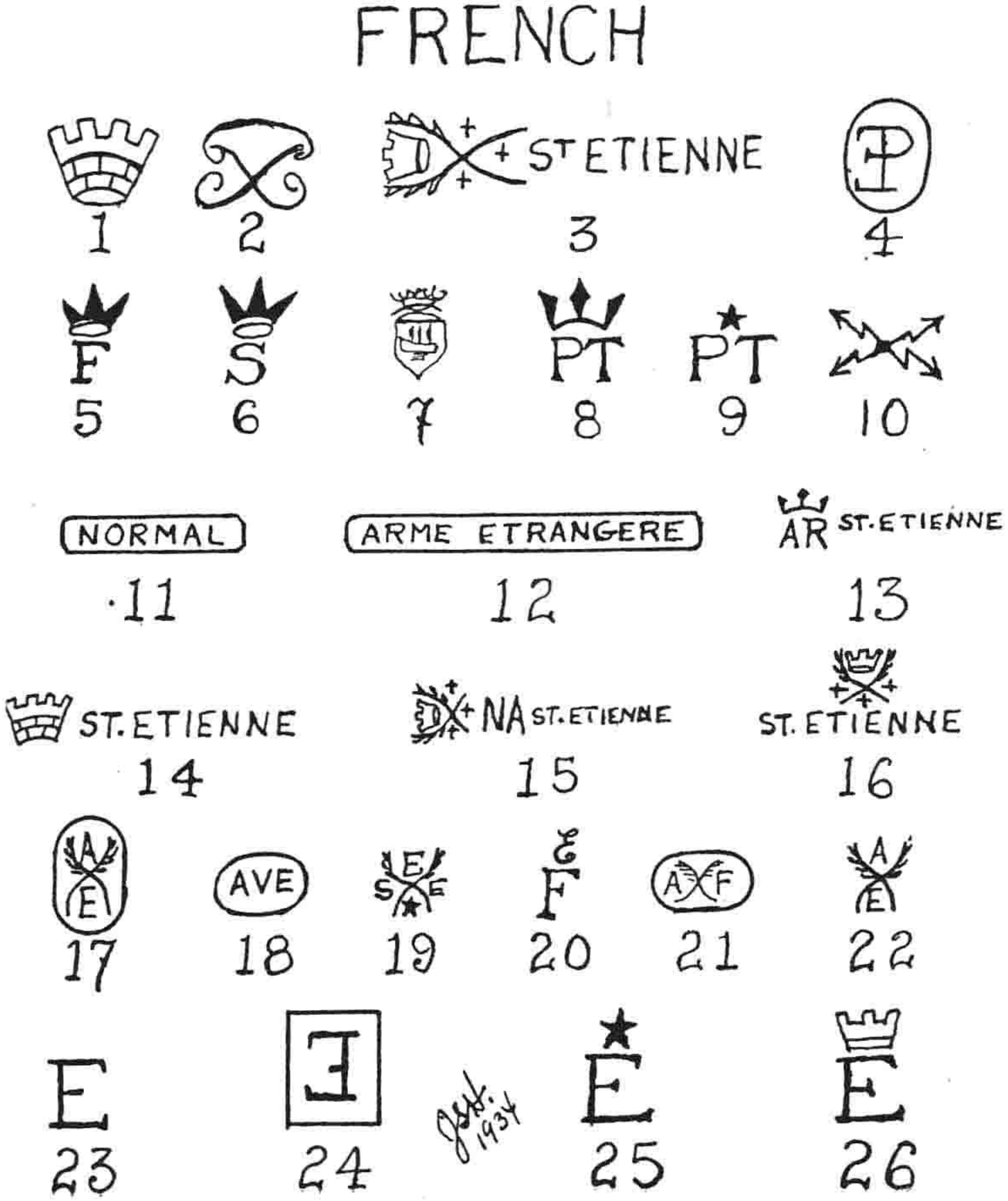
BELGIAN PROOF MARKS

1. Countermark of the Inspector. Any letter may be seen thus surmounted by a star, as the initial of the inspector is used.
2. The Monument, or "Perron" of Liege, indicating inspection after assembly.
3. A simplified form of the last described mark. It is more often seen as shown here.
4. The mark of acceptance.
5. Acceptance after proof with excessive charge.
6. Optional Provisional Proof of barrel for muzzle loader.
7. Standard Provisional Proof.
8. Double Proof.
9. Triple Proof.
10. Chamber stamp for shot guns. Shows bore dimension and chamber length.
11. Smokeless Powder Proof.
12. Special test with smokeless powder not officially recognized. This mark indicates test with E. C. Powder No. 3.
13. Same as last described mark, showing marking for another type of powder, in this case Clermonite.
14. Proof of barrel of low power target arm.
15. Proof of foreign arms.
16. Unfinished arms to be completed after exportation.
17. Mark indicating proof with a particular kind of smokeless powder.
18. An old Definitive Proof Mark, now obsolete.

locked up, charged with possessing stolen Government Property, and suffered great inconvenience before the matter could be straightened out.

Proof Marks

Besides the marks already described, there is another class of markings on firearms that are very interesting and important to the Identification expert. These are the "proof marks" that are always found on arms made or sold in any of several European countries. The proof marks and their use are stringently regulated by law in the countries where they are used, so that they form a sure method of determining the country of origin of many


FRENCH
ST ETIENNE
1
2
3
4
F
S
PT
PT
5
6
7
8
9
10
NORMAL
ARME ETRANGERE
AR ST.ETIENNE
11
12
13
ST.ETIENNE
NA ST.ETIENNE
ST.ETIENNE
14
15
16
AE
AVE
ESE
EF
AF
AE
17
18
19
20
21
22
E
E
E
E
23
24
JSH. 1934
25
26

foreign arms. This is likely to be a matter of considerable importance in the case of cheap firearms of uncertain make, as the proof-mark may be the only real clue to the origin of the arm. Moreover, American arms sold in the countries requiring proof-marks must bear a mark showing that it is an arm of foreign make which has been tested and found safe for sale. Thus, for example, a Colt Revolver bearing the Spanish proof marks must have been sold in Spain. The author has had in his possession several such arms. One is illustrated on page 270 of Textbook of Pistols and Revolvers and the Spanish proof marks can be seen on the frame where the barrel is screwed in.

Before proceeding any further with this subject of proof-marks, it is in order to say a word about the proof tests themselves, and the reasons for them. It is almost the universal practice to test all firearms during or following the manufacture, to be sure that they are sufficiently strong to prevent their blowing up in the hands of the user.

As the part of a rifle or shotgun most likely to burst is the barrel, many manufacturers make it a practice to test the barrels in the rough, before assembling them into finished guns, by firing a very heavy charge in them, which subjects them to a much greater pressure than they will ever be called on to stand in ordinary service. Thus, if the barrel is weak, or the metal is seamy, the rough bored barrel will split open or burst, and the maker will be saved the time and expense of finishing it up. Moreover,

---

FRENCH PROOF MARKS

1. The St. Etienne Mark for provisional proof of separate shotgun barrels.
2. The Paris Mark for the same proof.
3. The St. Etienne Mark for definite proof of barrels finished and assembled.
4. The Paris Mark for the same proof.
5. St. Etienne Black Powder Proof of finished arms.
6. St. Etienne Special Black Powder Proof.
7. Paris Mark for standard Black Powder Proof.
8. St. Etienne Mark for Standard Test with Smokeless Powder, "Poudre T."
9. Paris Mark for this test.
10. Mark placed on arms when ready for sale and delivery.
11. Mark indicating arms of standard dimensions.
12. Mark placed on arms of foreign make.
13. Proof of Rifled Arms.
14. Proof of hand weapons.
15. Proof of barrels finished but not assembled.
16. An old St. Etienne Mark.

17-20. Old marks formerly used at St. Etienne.

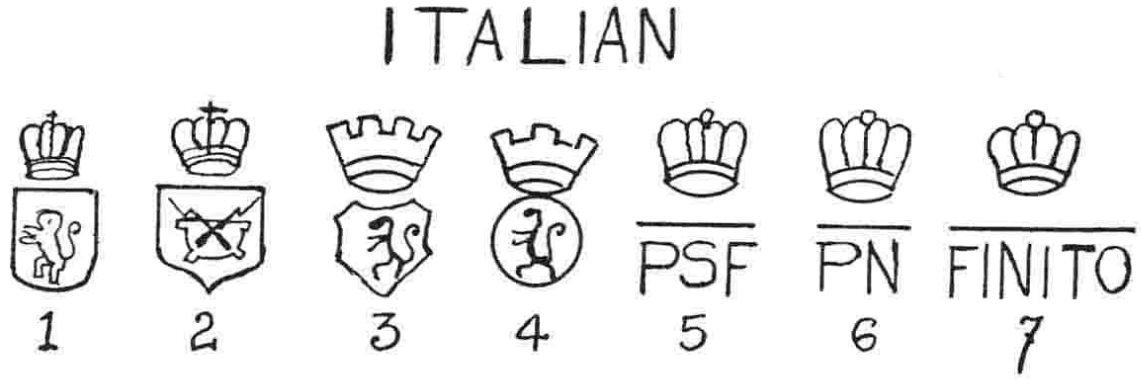
21. Mark used on French Government made arms.
22. A mark placed on foreign made arms proved at St. Etienne.

Special marks at one time placed on arms made at other French towns.

23. Chatellerault mark, the letter E.
24. Sailleville, reversed E in rectangle.
25. Mutzig, E surmounted by a star.
26. Tulle, E surmounted by a crown.

Note: For double proofs of barrels, the third mark in the top line has two sets of the crown and branches preceding the words St. Etienne; for triple proofs, three sets. In general, any of the marks given twice indicates double proof.

if the barrel should be assembled into a finished gun, and then should burst on the final proof, it would most likely ruin the other expensive parts of the gun, and would thus result in a considerable loss to the maker. Therefore, this first test is very desirable in cases where experience has shown that a certain percentage of the barrels may be expected to fail. Naturally, it is not to be recommended in the case of guns which never have to stand much pressure, such as a .22 short, where the barrel does not ever have to shoot a high powered cartridge. And where the quality of the steel used in the barrels is so uniformly high that failures very rarely occur, it is cheaper to put off the testing until the entire gun is finished, for all high powered arms must be tested after completion, regardless of any previous test of the barrel. This test of the partly finished barrel is what is called a "Provisional Proof."



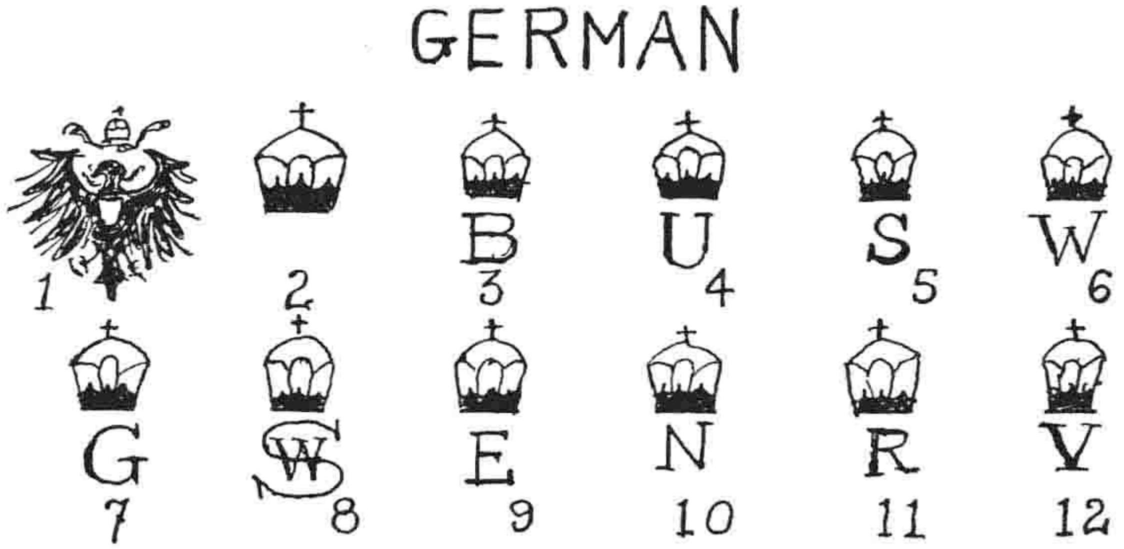
ITALIAN

1. National Small Arms Testing Bureau. Identifying mark of the Brescia Branch.
2. Identifying mark of the Gardone Branch.
3. Italian Proof House. Provisional Proof of barrel.
4. Italian Proof House. Mark on Rifled Arms.
5. Smokeless Powder Test. (Polvere Sensa Fumo).
6. Black Powder Test. (Polvere Nero).
7. Mark is added to the ones described above on finished arms.

When the entire gun has been finished, it is inspected to see that it is properly and safely made, which is called "Viewing," and it is then fired with one or more high pressure charges, and sometimes with regular charges also, which is called the final or "Definitive" proof.

In many countries, there are government rules or laws which forbid any gun to be placed on sale which has not passed certain prescribed inspections and proofs. In some countries these tests are made by a government proof house, and in others they are made by a proof establishment operated by a guild or co-operative association of gunmakers under government regulation. Some of the most notable proof establishments are those of Liège, in Belgium, which was visited by the author several years ago; The Gunmaker's Company in London, and the Guardians in Birmingham, which are arms makers' guilds, operating under government sanction; and the proof houses of Eibar and of Barcelona in Spain.

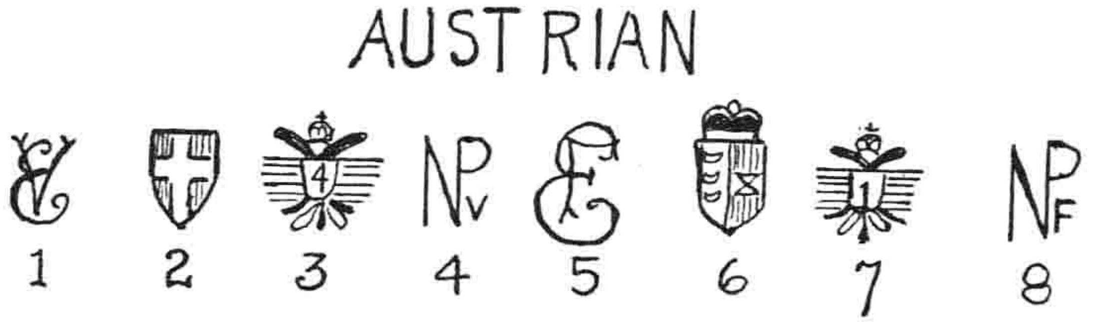
In Great Britain, for example, no gun can be placed on sale which has not been proved according to regulations recognized by these establishments. Some countries forbid the importation of unproved arms. For this reason, some American makers submit



GERMAN

1. Provisional Proof of barrel.
2. Single proof for pistols and revolvers.
3. Single proof of rifles and shotguns.
4. Together with No. 1, Definitive Proof of barrels and actions.
5. Shotgun mark.
6. This mark appears on choke-bored shotgun barrels.
7. Mark for Rifled Shoulder Arms.
8. Shot guns with a rifled portion in the choke.
9. Mark for "Express" rifles.
10. Nitro powder proof.
11. Arm re-proved after modification.
12. Mark used on guns already completed, but unsold, on passage of the proof law of 1891.

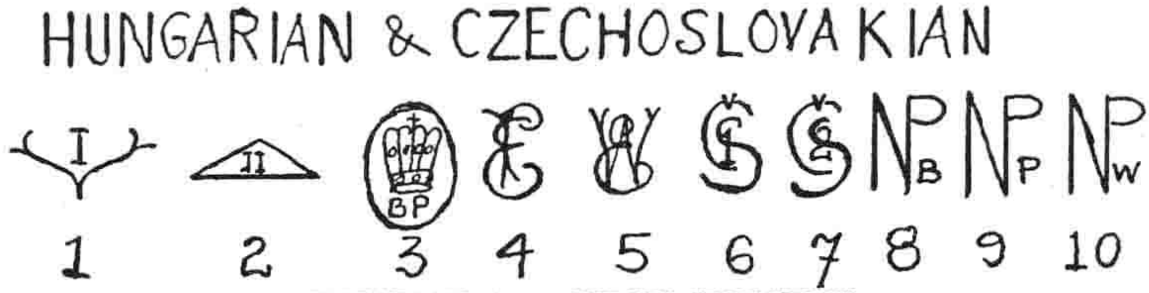
their arms to a proof test corresponding to those required by the British regulations, and place a proof mark of their own on all guns so proved; but the practice is by no means universal, as there are no rules whatever requiring arms sold in the United States to be proved, or to bear a proof mark. However, it has always been the practice of our Ordnance Department to proof-fire all guns made in the Government Arsenals, and to stamp the finished arm to indicate that the proof has been accomplished. Formerly there was a provisional proof as well as the definitive proof, but in late years the provisional proof of Government small arms has been omitted. Occasionally a gun will burst on final proof, and during the World War, when the quality of the barrel steel suffered from the rush to get production, the number of failures on final proof was fairly large by comparison, though it was never over a small fraction of a percent. When several thousand guns per day are going through the works, the loss of even one in 20,000 seems like a fairly large number. The author at one time was Officer in Charge of the Experimental Department at Springfield Armory, with an office right by the proof-house where he could hear the firing, which was continuous, as the entire production of the Armory had to be proof-fired. He soon got so that he could recognize at once the noise of a shot which caused the gun to fail, and he always used to stop whatever he was doing at the time of such an occurrence and go into the proof-house to investigate the damage, on the theory that by finding out just what happened and noting all that was to be seen, much could be learned.



AUSTRIAN

The first four are Vienna marks, as follows:
1. The first proof on single barreled shotguns.
2. The second proof on double barreled shotguns.
3. Third proof on multi-barreled guns, the second on single barreled guns, and the one and only proof required on pistols, revolvers, and small-bore arms.
4. Nitro-powder proof.

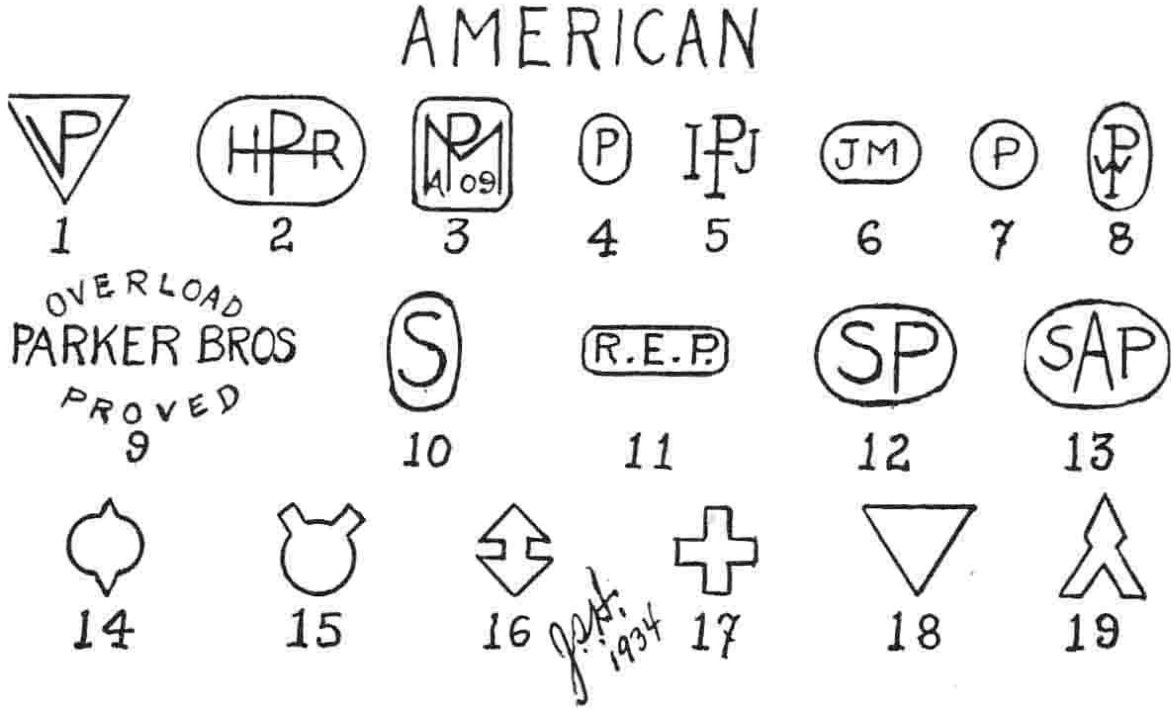
The remaining four marks are the same as above, except for the proof house at Ferlach.



HUNGARIAN AND CZECHO-SLOVAKIAN

1. Buda-Pesth, 1st proof, single barreled shotguns.
2. Buda-Pesth, 2nd proof, double barreled shotguns.
3. Buda-Pesth, 3rd test on multi-barreled guns, the second on double-barreled shotguns, the one and only test on pistols, revolvers and small-bore arms.
4. Prague, 1st proof.
5. Weipert, 1st proof.
6. Prague & Weipert, 1st, (Voluntary) proof of shotgun barrels.
7. Prague & Weipert, 2nd, (Obligatory) proof of shotgun barrels.
8. Nitro-proof, Buda-Pesth.
9. Nitro-proof, Prague.
10. Nitro-proof, Weipert.

By far the most comprehensive work that has ever been published on the subject of proof regulations, proof practices in various nations, and proof marks, is the series of articles by Col. Calvin H. Goddard, Ordnance Reserve, in ARMY ORDNANCE (magazine) on "Proof Tests and Proof Marks," beginning in November-December 1933, and running in five parts to finish in July-August, 1934. This excellent paper has, I am glad to report, been reprinted, and is available at $3 from The Arms Service Bureau, 469 East Ohio St., Chicago, Ill. This monograph is profusely illustrated with cuts of practically every proof mark of which a record or description could be found, and it should be in the library of everyone interested in firearms.



AMERICAN PROOF MARKS

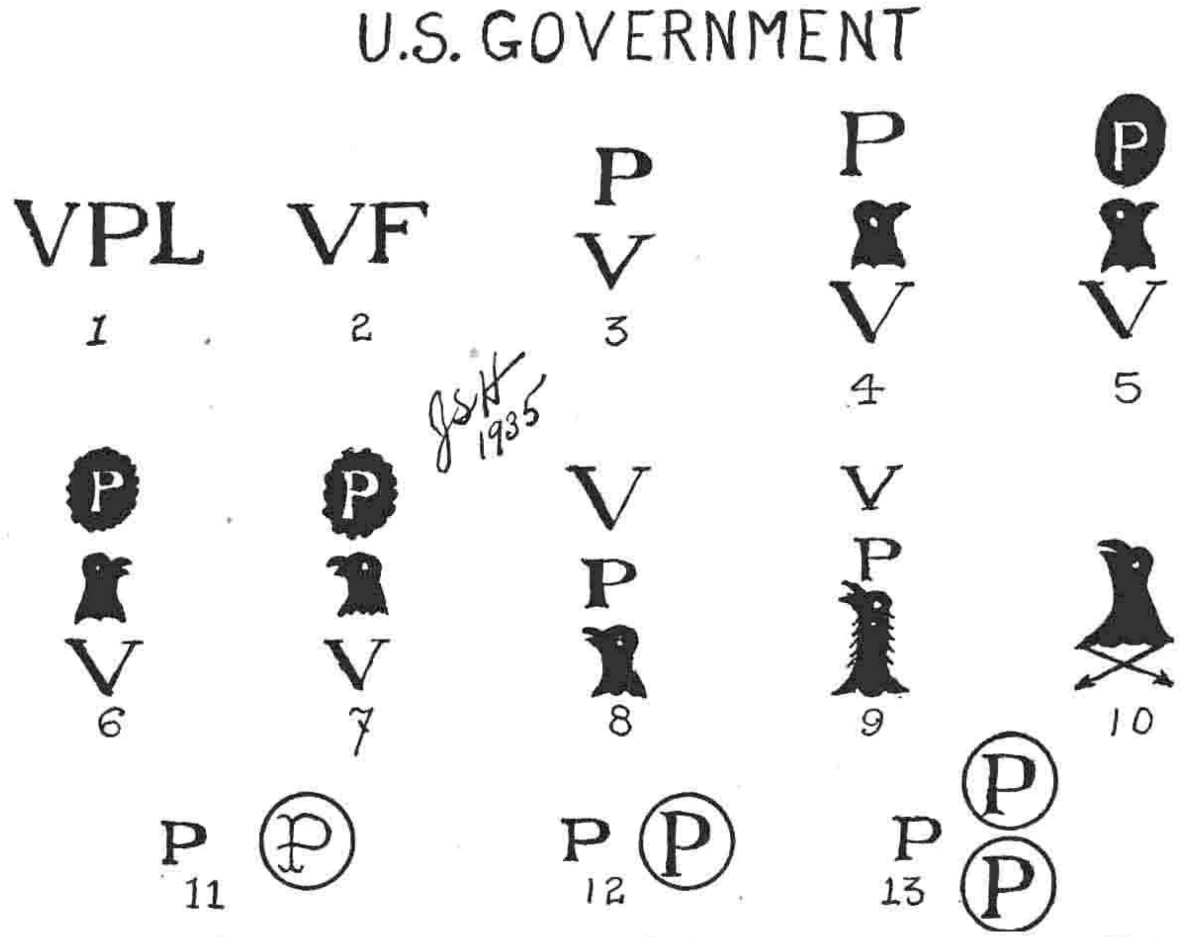
In the U. S. there is no central proof house, and no Federal law on the subject. Some makers regularly proof fire all guns, and others proof fire only those intended for export to countries requiring proof before sales. Each maker uses his own mark to indicate that the arm has been proved.

1. Colt Patent Fire Arms Co. proves all arms and uses the mark shown. 2. Harrington & Richardson proves arms intended for export, and marks those going to Australia and New Zealand. 3. Hunter Arms Co. prove all barrels and apply the mark shown. Iver-Johnson use the letter "P" in an oval for the provisional proof, 4 and the monogram IJP 5. for the definitive proof, 6. Marlin Arms Co. uses the letters JM in an oval. 7. O. F. Mossberg proves barrels intended for export, and stamps them with the letter "P," or with "P" in a circle, as shown. 8. Winchester Repeating Arms Co. subject all arms to a provisional proof, and later to a definitive proof, and use the monogram WP in an oval to indicate that the arm has received both proofs. Parker Brothers give all arms a definitive proof, 9. and stamp the barrels as shown. R. F. Sedgeley fires all rifles with a 50 percent overload, and marks them 10, with the letter "S" in an oval. 11. Remington Arms Co. prove all arms intended for export to countries requiring it, and mark guns so proved with the letters R.E.P. (Remington English Proof) in an enclosed space, as shown, Savage Arms Co. give their arms both a provisional and a definitive proof, 12. and mark the rifles so proved with the letters "SP" in an oval. The shotguns are marked with the letters SAP 13. in an oval. Proof marks used in common by the Ithaca Gun Co., 14-19, the Lefever Arms Co., and the Western Gun Corp., all of whom are located in Ithaca, and conduct their tests jointly. Guns are fired with an overload giving about 40 percent excess pressure.

The present author, in preparing sketches to illustrate this chapter, found many proof marks in Col. Goddard's article that were previously unknown to him; and with Col. Goddard's kind permission, he has copied the most important of them here.

Markings on the Cartridge Case

Important information may often be obtained from the maker's initials which are usually stamped on the head of the cartridge case. In America, there are five principal makers of pistol and revolver cartridges, besides the Frankford Arsenal, which makes only the U. S. Army service rifle and pistol cartridges, and the Federal Cartridge Co., which makes only .22 rim-fire cartridges and shotgun shells.

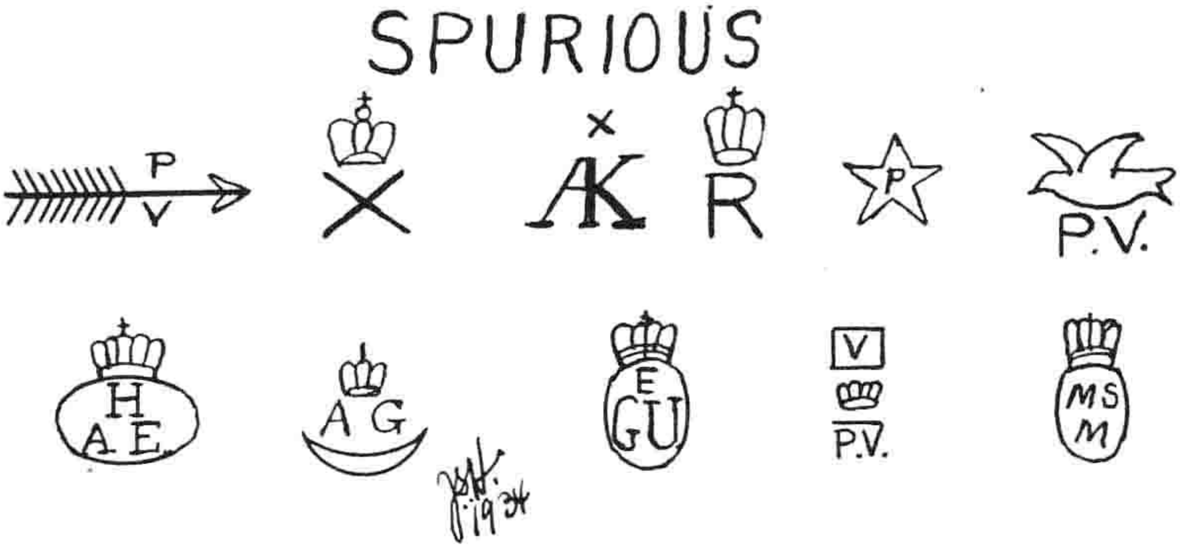


Various proof and view marks found on U. S. Government rifles or muskets. Their approximate periods are:—

1.	1799
2.	1802
3.	1803
4.	1806
5.	1819
6.	1824
7.	1837
8.	1842
9.	1857
10.	1869
11.	1878
12.	1903
13.	1934

Rim-fire cartridges have a wide flat space on the head of the case, which is unobstructed by the use of a primer. Most cartridge companies take advantage of this space to stamp thereon the initial of the company or some trade-mark.

Center-fire cartridges, on the other hand, have this space obstructed by the primer in the center, so that only the rim around the primer, between it and the edge of the head, is available for markings. Usually this space has the name or the initials of the maker stamped on it, together with the abbreviated name and caliber of the cartridge. The following tabulation gives some of the more commonly seen markings.



Markings found on unproved arms. These spurious proof marks, or markings intended to look like proof marks, are used by the unscrupulous maker of cheap arms for the purpose of misleading the uninformed or unwary customer. (Sketched by the author from illustration in Col. Goddard's article by permission).

Peters Cartridge Co., Kings Mills, Ohio. Rim-fire cartridges are marked "P". Center-fire markings, "Peters" or "P. C. Co." and the caliber and name of cartridge, as "Peters .38 S. & W."

Remington Arms Co., Bridgeport, Conn., (Formerly Remington Arms—Union Metallic Cartridge Co.,) Rim-fire cartridges are marked "U" (for Union Metallic Ctg. Co.), and center-fire cartridges are marked "REM-UMC .45 Colt," or similar markings for the other calibers.

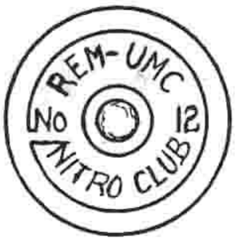
United States Cartridge Company, 50 Broadway, New York City. Rim-fire markings—"US". Center-fire, "U.S.C.Co. .32 A.C.P." etc.

Western Cartridge Co., East Alton, Ill. Rim-fire, a diamond, or for the Super-X cartridges, the word "SUPER" on top of a large "X". For center-fire the word "WESTERN" and the caliber and name of the cartridge.

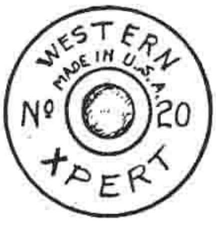
Winchester Repeating Arms Co., New Haven, Conn., (owned by the Western Cartridge Co.). For rim-fire, "H" (for Henry; the company originated about 70 years ago from a re-organization of the Henry Arms Co.). For Center-fire, "W.R.A. Co." and the caliber and name of the cartridge, as "W.R.A.Co. .30 LUGER," etc.

Federal Cartridge Co., Minneapolis, Minn. make only .22 cal. cartridges and shotgun shells. Marks, "F" or "FEDERAL."

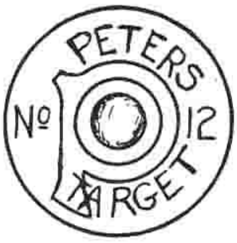
Frankford Arsenal, Philadelphia, Pa. Make the .30 and .50 caliber service cartridges, and the .45 caliber automatic pistol cartridges for the Army, Navy, Marine Corps and the National Guard. Much of this ammunition is seen in the hands of the public, as it is sold to members of the National Rifle Association, and is also furnished to rifle clubs and to competitors at the Na-


REM-UMC
NO 12
NITRO CLUB

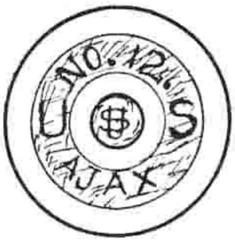
1


WESTERN
MADE IN U.S.A.
Nº 20
XPERT

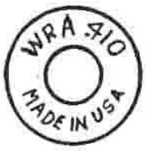
2


PETERS
Nº 12
RGET

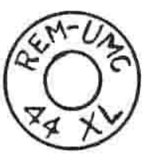
3


NO. 12
U S
AJAX

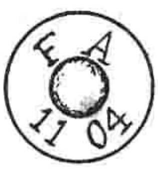
4


WRA 410
MADE IN USA

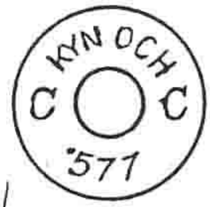
5


REM-UMC
44 XL

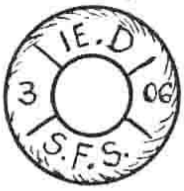
6



7

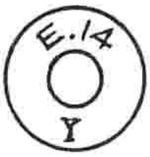

KYNOCH
C C
.577

8

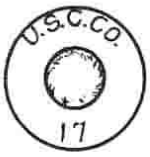


9

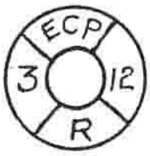
JH. 1935



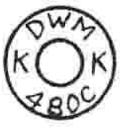
10



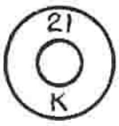
11



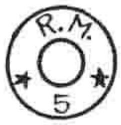
12



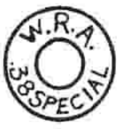
13



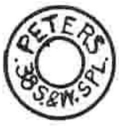
14



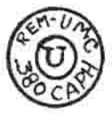
15


W.R.A.
.38 SPECIAL

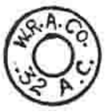
16


PETERS
.38 S&W. SPL.

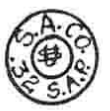
17


REM-UMC
U
380 CAP H

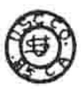
18



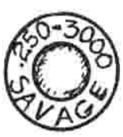
19



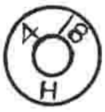
20



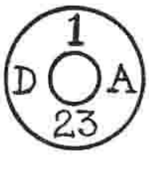
21


.250-3000
SAVAGE

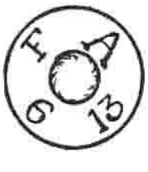
22



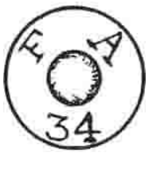
23



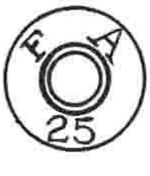
24



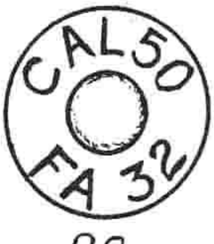
25



26



27



28

tional Matches. Rifle cartridges made by Frankford are marked with the initials "F A" and the date, by month and year, e.g., F A 6 34. The ammunition made especially for the National Matches is sometimes marked with the initials F A and the year, with the letters "N M," (National Match), e.g., F A 31 NM. Some of the ammunition made especially for the matches was marked with the letter R on the head, indicating that the cartridge case was made with the "Hard Rifle Anneal" for easy extraction. Armor piercing ammunition has a black tip on the bullet. Formerly the tracer cartridge had a black case, but it was found that the blackening of the brass by chemical means had a tendency to

---

TYPICAL MARKINGS ON THE HEADS OF CARTRIDGES

These sketches were carefully made from actual samples in the author's possession. Both foreign and domestic ones are shown, and some rather old ones have purposely been included, for very often the cartridge that may figure in a shooting case has been lying forgotten for years in the chamber of some old gun in a household where arms are seldom or never used.

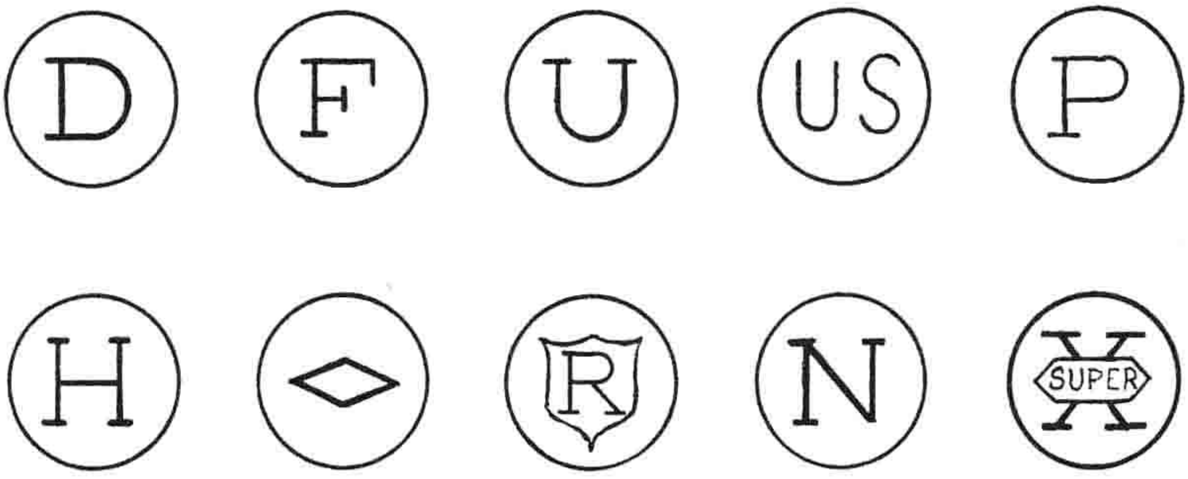
1. Remington 12 gage shotgun shell.
2. 20 gage shotgun shell made by Western Cartridge Company.
3. 12 gage shotgun shell by Peters Cartridge Company.
4. 12 gage shotgun shell by U. S. Cartridge Co. Note the monogram on the primer. Formerly it was the practice to place monogram or initial on primers used for smokeless powder, while those intended for black powder were left plain. At present, all standard primers are intended for use with smokeless powder, and will work equally well, with black, so that the initial on the primer is not often used.
5. .410 gage shotgun shell by Winchester Repeating Arms Co.
6. .44 Metallic shot cartridge, for use in rifles.
7. .30 caliber Krag cartridge made at Frankford Arsenal, November, 1904.
8. Cartridge for .577 Elephant gun, with 750 grain bullet and 110 grains of Cordite. Made by Kynoch, Ltd., in Great Britain.
9. 8 MM French service cartridge for the Lebel Rifle.
10. .455 Webley Self Loading Pistol Cartridge, made by Eley, London. Purchased in 1932.
11. Wartime .45 Automatic pistol cartridge, made by U. S. Ctg. Co.
12. Foreign 11 MM revolver cartridge.
13. 9 MM Luger Pistol Cartridge, made by Deutche Waffen und Munition Fabriken at Karlsruhe. The number 480C marked on the base is the factory pattern number of this particular cartridge. Other D. W. M. Pattern numbers are as follows;

403	7.63 MM Mauser	480D	9 MM Luger carbine
413A	6.5 MM Bergman No. 3	484	5 MM Clement
416A	5 MM Bergman No. 2	487	9 MM Mauser
456B	9 MM Bergman "Mars"	488	8 MM Bergmann Simplex
466	7.65 MM Mannlicher	497	7.65 MM Mannlicher carbine or carbine pistol
471	7.65 MM Luger		
479A	7.65 MM Mauser (.32 A. C. P.)	508A	6.35 MM Automatic (.25 A. C. P.)
480C	9 MM Luger Pistol	540	9 MM Short

14. 9 MM Luger pistol Cartridge, German make.
15. 9 MM Cartridge for Bayard Army Pistol.
16. .38 Smith & Wesson Special made by Winchester Repeating Arms Co.
17. .38 Smith & Wesson Special made by Peters Cartridge Co.
18. .380 made by Remington with the old marking ".380 CAPH." (Colt Auto Pistol Hammerless).
19. .32 A. C. P. made by Winchester.
20. .32 A. C. P. made by Savage, marked .32 S. A. P. (Savage Automatic Pistol).
21. .25 A. C. P. made by U. S. Ctg Co. (Old).
22. .250-3000 cartridge made by Savage Arms Co.
23. 9 MM Browning Short Cartridge, German made.
24. 8 MM Swiss service cartridge made at Government factory, Altdorf.
25. .45 caliber pistol cartridge made at Frankford Arsenal, showing old marking.
26. Same, showing present method of marking.
27. .30 caliber M 1 rifle cartridge, made at Frankford. Note that primer is crimped in.
28. .50 caliber ball cartridge, made at Frankford.

cause deterioration of the metal, and now the tracer cartridges have a red tip on the bullet for red tracer, and a green tip for green tracer. The armor piercing cartridges formerly had a black bullet, but now they have a black tip on the bullet. High pressure proof cartridges are tin plated, and marked on the head with the initials F A and the word "TEST." Beware of such cartridges!

Pistol cartridges made by Frankford formerly had the initials F A and the month and year of manufacture; but the later ones have only the initials and the year of manufacture. Example of the older markings, F A 7 13; of the later ones, F A 34.



Markings on the heads of .22 rim fire cartridges. Top row, reading from left to right: Dominion Cartridge Co., Federal Cartridge Company, Remington, United States Cartridge Company, Peters Cartridge Company. Bottom row: Winchester Repeating Arms Co., Western Cartridge Co., Rheinische-Westfalische Sprengstoff A. G., Nobel, Western Super-X. The U on the Remington cartridge remains from the time when there were two separate companies, the Union Metallic Cartridge Company and the Remington Arms Co. The H on the Winchester cartridges originated when it was the Henry Repeating Arms Co.

Dominion Cartridge Co., Montreal, Canada. Marks, "DOMINION" or "D".

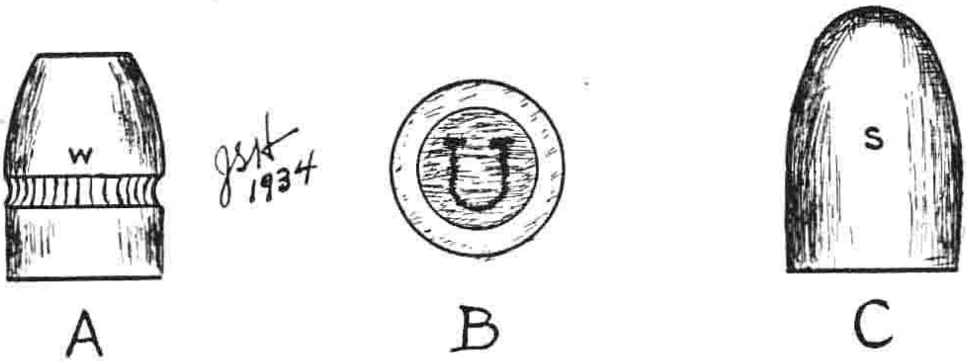
Imperial Chemical Industries, Ltd., of Great Britian-"NOBEL" or "N".

Rheinisch-Westfälische Sprengstoff, A.-G., of Nürnburg, Germany, "RWS" and the caliber for center-fire cartridges, and the letter "R" in a shield for rim-fire. Some practice cartridges made by this firm are marked "U" in a shield.

Cartridges made by the Deutche Waffen und Munitions Fabriken of Berlin, are marked D.W.M., with the pattern number of the cartridge. For example, the .30 Mauser cartridge is marked 403, and the 9 MM Luger 480C, while the stronger Luger cartridge intended for the carbine is marked 480D. Sometimes Luger cartridges with a black case may be encountered; the black case indicates the stronger carbine cartridge.

Cartridges made by Kynochs Ltd., in Great Britain are marked with the word KYNOCH and the caliber. Those made by Eley are marked, "E," "ELEY" or "ELEY LONDON." The author has samples marked in all three ways.

Many of the cheaper foreign made cartridges made for use in the pocket automatic pistols, and sold in pawn shops have no marks at all on the head; and unfortunately, these are precisely the ones that the identification expert is most likely to encounter, for they are perhaps the most likely ones to be found in the possession of cheap and ordinary criminals. However, even when there are no marks at all on the cartridge case, something is learned, for this fact at once tells the story that the cartridge was not one of the well known American makes, and points a strong probability as to the origin of the purchase, that is the pawn shop.



MARKINGS ON THE BULLET.
Occasionally the bullet will be found to bear some initial or mark indicating which company manufactured it. The examples shown above were sketched from actual samples. A—Bullet marked "W" on side made by Winchester Repeating Arms Co. B—Base of .45 Automatic pistol bullet, Remington make, showing letter "U" stamped into lead core exposed at base. C—.45 Automatic pistol bullet marked "S" on side, made by U. S. Cartridge Co.

Manufacturer's Marks on Bullets

In the past, it has at times been the practice of certain ammunition makers to stamp a small initial or other mark at some inconspicuous place on the bullet. For example, at one time all metal jacketed bullets of Winchester make had a small "W" stamped on the side of the jacket, just where the curve of the ogive starts, and bullets of the United States Cartridge Company's make had a small "S" in the same place.

The practice of the various makers in this regard is liable to change at any time, and many companies who formerly used some such system no longer find it desirable or necessary, while others probably will in the future find it expedient to adopt something of the kind for a part or all of their production.

Thus, experimental lots of bullets, special lots made for one purpose or another, bullets made up to be sold separately to reloaders instead of assembled into finished ammunition at the factory, and other bullets that differ from the ordinary production from any cause, might be so marked. An easy way to put a special mark of this kind on the bullet is to engrave the desired character or symbol, which might consist of a circle, star, initial, etc., on the punch which is used to form the base of the bullet in the swaging or final shaping operation. In this case the symbol will be imprinted on the base of the bullet. Such markings will often be found on the exposed lead at the base of a metal cased bullet.

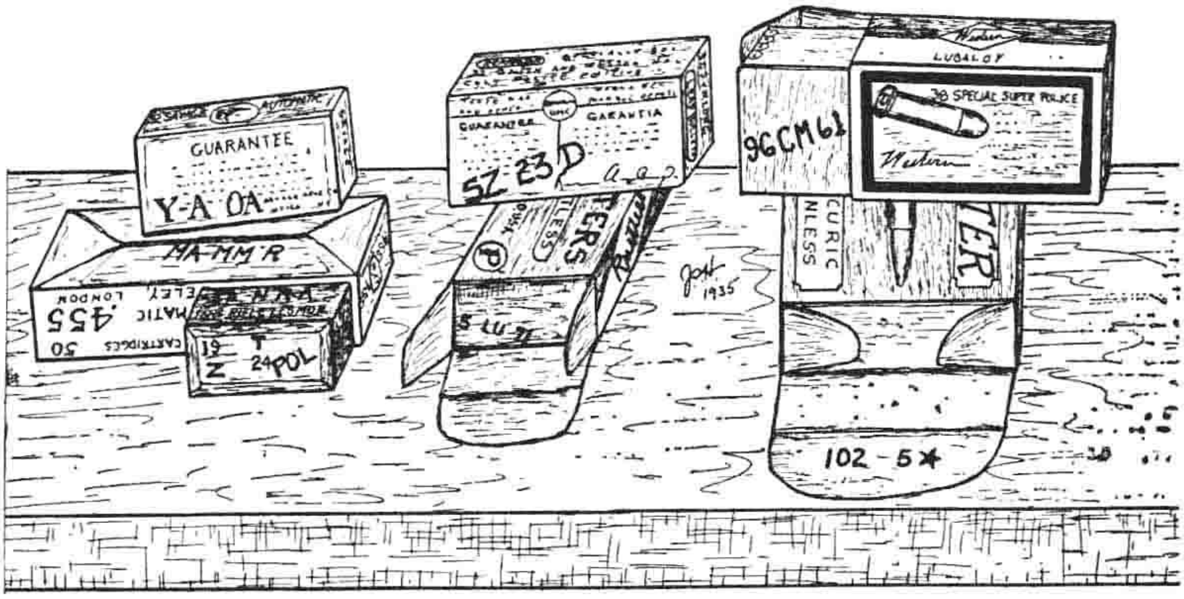
If the investigator does not realize that there may be such initials, etc., and does not look specially for them, they will most likely pass unnoticed. If found, they are likely to be an important aid in determining the make or type of the bullet, and therefore any evidence bullet should be carefully examined for special markings and their description and location should be recorded.

Markings on the Cartridge Box

When it is possible to locate the box containing the unused cartridges from which the suspected one came, it will often prove to be a fruitful source of information. The outside label on the box will give the caliber and type of the cartridge and invariably the manufacturer's name and address; although this latter information may not be included in a few cases involving cheap cartridges of foreign origin, or domestic cartridges intended to be smuggled out of the country in violation of the neutrality laws.

The cartridge boxes of all legally sold ammunition will show the maker's name and address, and generally on the bottom of the box, or on the inside surface of the lid or flap will be found some odd numbers printed with a rubber stamp. These stampings are queer combinations such as "4EG2" or "L15ESF 35" or "03 C R" and have no apparent meaning. However, they may prove of the utmost importance, and all such data should be carefully recorded, as they are the manufacturer's index of the exact "Lot Number" of this particular batch of ammunition. Each maker keeps a detailed record of each and every lot of ammunition be ever loaded. If the manufacturer is given this Lot Number correctly, he can supply any desired ballistic information relative to this particular lot of cartridges. Furthermore, it may be possible to obtain from the factory other cartridges of this particular lot of ammunition, as a supply is kept in storage for the purpose of making "check" tests in case any complaint is ever received relative to this lot of cartridges after they have gone out on the market.

The store from which the suspected box of ammunition was purchased can often be definitely located by means of these Lot Numbers. The various ammunition companies are generally represented by one particular jobber or dealer for a certain locality and often one particular make of cartridge can only be obtained from this one source. By checking against the dealer and jobber stocks and records, and searching for boxes stamped with this same marking, much valuable information may often be obtained as to who handled the sale of, or purchased the box in question.



LOT NUMBERS

Lot numbers may be found in various out-of-the-way places on the cartons in which ammunition is packed. A favorite place for them is on the bottom of the carton, as will be seen from the sketch, made from "life."

Left, a box of 50 cartridges for the .455 Webley Self Loading Pistol, made by Eley brothers, London. The lot symbol MA MM R is found on the bottom of the wrapping which encloses the pasteboard box. On top of this is a box of .32 A. C. P. cartridges made by The Savage Arms Co. The lot symbol Y-A OA is stamped on the bottom of the box. Lying on its side in front of the other two is a box of U. S. Cartridge Company's .22 long rifle cartridges, which has a number of symbols stamped on the bottom.

Middle, A box of .32 S. & W. Longs of Remington make, lying on its side with bottom visible, showing the lot number SZ 23 D stamped over the guarantee. Under it is a box of Peters .38 Police Positive cartridges, showing the lot number 5 LU 71 stamped on the end of the inner sliding portion of the box.

Right, bottom view of a box of Western .38 Special Super Police, with lot number 96CM61 stamped on bottom of inner sliding part. It is lying on a box of Winchester Staynless .30 cal. U. S. Gov't rifle ammunition, with lot number 102 5* stamped inside the flap of carton.

CHAPTER 6

INSTRUMENTS AND EQUIPMENT

THERE are several essential instruments which *must* be on hand before any firearms identification of the advanced, or laboratory type can be undertaken, and there are a number of others which may be regarded more or less as luxuries; that is, they are useful, and they make the work easier, and in some cases, they may determine the difference between success or failure; but they are not used or needed in *every* case, and therefore they are often omitted, from reasons of economy or necessity.

The writer is acquainted with the equipment of several successful bullet identification laboratories, and he has noted a very wide variation in the number and kind of instruments provided. An attempt will be made in this place to give an idea of what is usually found, what is indispensable, and what is desirable, but not absolutely necessary. For the convenience of the reader who is going to fit up such a laboratory, the trade names and present list prices of the apparatus is given whenever this information is available. In regard to measuring instruments, and also with most of the other apparatus, there are several makers and sources of supply; the author has made no effort to mention all the patterns and trade names, for the duplication involved would become tiresome. He has decided to give the trade name and price of the particular instrument that he himself happens to be using, because he is best acquainted with that material; in general he does not thereby imply that some other make would not be just as good, or even better. For example, several Starrett measuring instruments are mentioned. This is an excellent make, but another which has the very highest esteem among toolmakers is Brown & Sharpe; and Goodell Pratt make excellent instruments of this kind.

A most important part of the bullet identification laboratory, which, unfortunately for those aspiring to enter this field, cannot be purchased at all, is a very complete file of information regarding various firearms, cartridges, and their characteristics. Usually this is the work of one man who has made this subject his hobby for years, and has laboriously collected the required data over a long period of time. As an example of the extent of such an undertaking, it may be mentioned that the card index of bullet weights alone, collected by Lieut. Fowler, Firearms Identification expert of the Metropolitan Police Force of Washington, contains over 3200 cards.

Another most important thing is a reference collection of arms, and of cartridges. Live cartridges of every make in every caliber should be on hand, and the investigator should have sample fired cartridges and bullets from each make and model of arm that is ever likely to be encountered in this work. Perhaps the most complete collection of this kind is the one gotten together by Col. Goddard, whom the author believes to have more information on such subjects than any other one man in the world.

In making this collection of fired cartridges and recovered bullets from known arms, the worker should bear in mind that it is well to have samples from at least two individual guns of each type, so that some idea can be gained of the differences to be expected between guns supposed to be the same. In like manner, he should have at least two recovered bullets and fired cases from each individual gun that is fired, so that he can see how much difference there is between different bullets from the same identical gun. There will always be some differences between the fatal bullet and the test bulllet, even if they both came from the same weapon, and the inexperienced operator, who did not know this would be badly misled. The character of the differences to be expected can only be known by a long and careful experience in examining known samples.

As to actual instruments, the number really necessary is not large, but some of them are expensive. The author knows of one very successful laboratory which has the following equipment, which is just about the minimum that the investigator can get by with.

Bullet comparison microscope with lamps and camera.
48 mm and 72 mm lenses for direct photography.
5 x 7 Eastman view camera, with lens and shutter.
"Crown" tripod.

Adapters for holding the 48 mm & 72 mm lenses in Eastman camera.

Fully equipped dark room for photographic developing and printing.

Focusing glass for camera.

Bullet scales.

Micrometer calipers.

Magnet.

Bullet recovery box.

The author of this book has the following material on hand for this kind of work:

Bullet comparison microscope, with lamps and equipment.

Micro-tessar lenses for direct photography.

Two cameras, with shutters, and various lenses, exposure meters, etc.

"Crown" tripod, with tilting top.

Two other tripods, attachment for holding camera for vertical photography, etc.

Bausch & Lomb focusing magnifier for camera.

Bullet scales.

Micrometer calipers, Browne & Sharpe No. 15RS.

Caliper Square, 6 inch, Browne & Sharpe, No. 560.

Flexible steel scale, 3 inch, Starrett's No. 321.

Taper Gauge, Starrett's No. 269A.

Magnet.

Bullet recovery box.

Prism, for photographing breech face of revolver.

Barrel reflector.

Barrel telescope.

Reading glass.

Aplanatic Pocket magnifier, B & L 7½ power.

3 watchmaker's magnifying glasses, different focal lengths.

Magnifying glass on stand.

Binocular microscope, Greenough wide field type, Spencer make, with assorted paired objectives and oculars.

Two laboratory microscopes, with assorted objectives and oculars giving from 12 to 1500 diameters magnification.

Filar micrometer eyepiece for microscope.

Stage micrometer for use with filar micrometer.

Miscellaneous attachments and materials.

In planning for the purchase of firearms identification equipment or instruments, the kind of work which it is intended to enter should be taken into consideration. All endeavor of this kind may be divided into three classes, each of which requires a somewhat different equipment from the other two.

To be considered first, as requiring the simplest equipment, is what may be called preliminary firearms investigation. This is simply the application of keen observation, good common sense, and a profound knowledge of firearms and ammunition and how they work to the clarification of problems connected with cases in which shooting is a factor. This is the kind of work that can be done by the average gun crank, or the man who has made a study of firearms his hobby. Nine times out of ten, few, if any, instruments are needed, and these few are usually the ones that would be in the possession of a firearms enthusiast in any event.

The second class of work is that which involves the identification of a fired cartridge or bullet as having come from a particular individual gun. This work involves a considerable degree of laboratory training and experience, and a familiarity with scientific methods and instruments, particularly with microscopy and photography. In this book, work of this kind is called "Advanced Firearms Identification." It requires a complete comparison microscope and photomicrographic camera, with several accessories, as will be described in detail below, together with a fully equipped photographic darkroom.

The third and last class of work considered in this connection is the research work which is being done by those leaders in this field, such as Col. Goddard, who not only practice advanced firearms identification, but who also are engaged in broadening and developing this science, and who are equipped to handle the most difficult and abstruse cases. Such a research worker will need several complicated and expensive instruments, which would seldom, if ever, be used by the routine worker.

With this explanation out of our way, we will now proceed to describe in some considerable detail the various instruments needed by all three of these classes of workers.

INSTRUMENTS USED IN ELEMENTARY FIREARMS INVESTIGATION

The instruments and apparatus needed are very few, and are inexpensive. The following list includes the necessary ones, with a brief description of their use.

Magnifying Glass

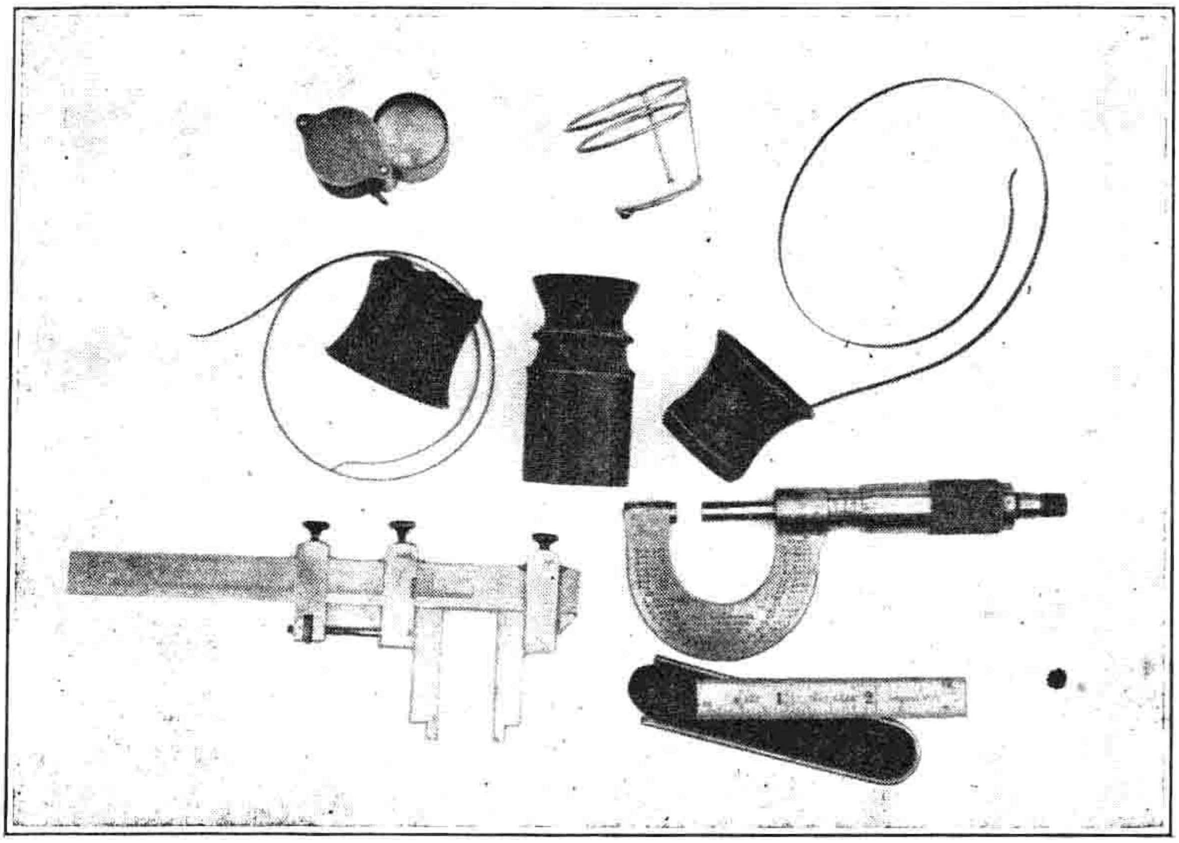
A small hand magnifer, of the kind that can be purchased at any optical store for about a dollar or more is indispensable. It is used for examining bullets, cartridge cases, and guns for markings, serial numbers, etc. Bausch & Lomb folding pocket magnifer No. 56, with a lens 25 mm. in diameter, and a magnifying power of 4, which retails for $1.00 is very satisfactory. The triple aplanatic magnifier, Catalog No. 168, giving a magnification of 7.5 times, and listing for $7.50, is a high grade glass. Sometimes a watchmaker's glass or loupe will be found even more convenient than the hand magnifier described, as it can be held in the eye, thus leaving both hands free. The most suitable is Bausch & Lomb No. 144 LP, which has a detachable spring to pass around the head and thus hold the glass in place. It lists for $1.40.

Micrometer Calipers

It is indispensable to have available a good micrometer caliper, with which the diameter of bullets may be read in thousandths of an inch. These instruments come in various sizes. The most suitable is the 1-inch size, which will cost about $10.00.

Many people who have never used a micrometer caliper will get false readings with this instrument, because, as with any other precision instrument, a certain amount of skill is necessary to use it correctly. Any machinist or tool maker can show you how to use a micrometer caliper correctly in a few minutes. The principal thing to guard against is the tendency of the uninstructed to turn the handle too hard. The instrument has a plunger which is threaded with a fine screw of 40 threads to the inch, so that each revolution of the handle advances the plunger 25 thousandths of an inch. This fine screw affords a tremendous leverage, so that if force is applied in turning it, almost any reading at all may be obtained, as the micrometer will simply crush down the object as the screw is turned. In turning down the handle, care must be used to employ a delicate touch, and to stop as soon as the plunger is in contact with the object to be measured. Uniformity of force applied is necessary if consecutive readings are to be comparative; it will not do to turn the handle hard one time and easy the next, else the results will differ every time, depending on the force applied rather than the size of the object.

A very convenient attachment to the micrometer, which minimizes the variations in force likely to be used by those who are not skilled in the use of this instrument, is the ratchet stop. This is a small supplementary handle, connected to the main handle by a spring ratchet, so arranged that only a certain predetermined amount of force, according to the tension of the ratchet spring, can be transmitted to the main handle when this supplementary handle is turned. By using only this ratchet to turn the handle with, the trouble above mentioned, of getting variable readings on account of a variation in the twisting force applied to the handle, is avoided. Micrometers can be purchased with or without the ratchet stop, which costs about fifty cents additional. Starrett's Micrometer caliper No. 3, listing at $10 has this attachment; a somewhat less expensive one, which is very satisfactory, and which also has the ratchet when so ordered, is No. 436, listing at $6.75 with ratchet, or $6.25 without it.



Some of the tools found useful in preliminary bullet identification. Top, left, Bausch & Lomb aplanatic magnifier, 7.5 power. Next, watchmaker's glass fitted to slip over the lens of a pair of spectacles. Middle of picture, Bausch & Lomb Focusing Magnifier, for use in getting the image sharply focused on the ground glass. On the right, Bausch & Lomb watchmaker's glass, 3 inch focus, with removable spring for holding it in the eye. The spring goes around the back of the head. Left, a similar glass with spring removed. Bottom, left, vernier calipers, useful for measuring the overall length of cartridges, etc. Right, 1 inch micrometer calipers, and Starrett 3 inch flexible steel rule No. 321.

The points of the ordinary micrometer caliper are too thick to go into the grooves left on the bullet by the rifling, and if it is desired to compare the diameter of the grooves in an evidence bullet with those on a test bullet, the readings cannot be taken with the ordinary micrometer. It is an advantage to have the points with a good wide bearing, especially when measuring soft materials such as lead bullets, because fine points would have a tendency to sink into the surface easily under the force of the screw, and thus make the readings uncertain; moreover, they have a tendency to mar the evidence bullet. However, as a difference in the diameter of the evidence bullet and the test bullet shows conclusively that they did not come from the same gun, it may at times be an advantage to be able to measure the diameter of the grooves in the bullet, corresponding to the bore or land diameter of the gun. This is perhaps more important to the preliminary investigator, or the one who does not use the comparison microscope, than it is to the man who does. The man with the comparison microscope available will simply put the bullets under the 'scope at once, and will find in this way that they do or do not match; while the man with no comparison microscope available will have to find some other way to prove this, or at least to do the preliminary work of finding out perhaps that the diameter *is* the same, and that further work must be done with the microscope by someone who has one. If the evidence bullet is smashed out of shape, as it all too often is, any such measurement may be out of the question anyway. For these reasons, the author finds that very few experts on identification equip themselves to measure diameters of the grooves left by the lands on the fired bullet. The simplest way to make such a measurement with a reasonable degree of accuracy is with a micrometer caliper which has narrow points. Such an instrument is the so-called micrometer screw thread comparator, made by Starrett, catalog number 210, listing at $7.00. This is simply a micrometer caliper with the points tapered to a diameter of about 1/64 of an inch, and reading zero when they are together. The author fully realizes that when some of his readers who know something about measuring tools see this, they will think that he is talking about the screw-thread micrometer, which has a point on one anvil and a groove on the other, and is not suitable for measuring anything else except the diameter of a screw. The author does *not* mean a screw-thread micrometer, which correctly measures the pitch diameter of the screw, and will measure nothing else. He is referring to a simple micrometer which has the anvils tapered to a point, and which is sometimes used for the specific purpose of measuring the diameters of screws, though it does this incorrectly, and is only useful on screws for comparisons. It is, however, a perfectly good and accurate caliper for straight measurements, with points small enough to go into the grooves left on a bullet, and at the small price charged for it, is well worth a place in the kit of every firearms man, though it must be frankly stated that very few seem to use it for this purpose. Very likely most firearms experts never even heard of it, but it is a good instrument.

Reading a Micrometer Caliper

As stated above, the screw on the micrometer caliper has 40 threads per inch, and therefore advances 25 thousandths of an inch for each turn. The barrel of the micrometer has a horizontal mark corresponding to each turn, and there are forty of these marks on the barrel of the 1-inch micrometer, with every fourth one made longer, and the long ones numbered 1, 2, 3, etc. up to 10. These are tenths of an inch, and the short divisions are each 25 thousandths. The thimble of the micrometer, the part that turns, has twenty-five vertical lines on its beveled edge, and each one of these lines represents a thousandth of an inch. To read the instrument, count up the total number of horizontal lines that show below the edge of the thimble, and multiply this number by 25; then add the number of small vertical lines on the thimble from 0 around to the vertical line on the barrel where the horizontal graduations are. For example, three horizontal lines show below the thimble, and the fifth line from 0 on the thimble is at the vertical index line on the barrel. This is a reading of 80 thousandths of an inch. The process of counting up the horizontal lines showing below the thimble is facilitated by the fact that every fourth line is numbered to indicate tenths of an inch. Suppose, for example, that we are measuring a .45 caliber pistol bullet. We find that there are 18 horizontal lines below the thimble, but we do not actually count the whole 18 of them; instead, we first see that the longer horizontal line with the number 4 is the last long one visible, so we have four-tenths of an inch to start with, and we simply count the remaining short lines between this and the thimble, which will be two. This is 50 thousandths, so we have .450, and we must add the reading of the thimble itself, which in this case will perhaps be 2, so we have the complete diameter as .452 inch. Care must be used in reading a micrometer caliper; even experienced machinists, who read these instruments every day sometimes make a mistake of one division, or 25 thousandths, by looking at the instrument hurriedly or carelessly.

Bullet and Powder Scales

It is absolutely necessary to have available a scale or balance with which to weigh bullets, for the weight is an important part of the identification of any recovered bullet. Most recovered bullets are the same weight as when they were fired, though if a high velocity lead bullet, or even a jacketed bullet strikes a heavy bone, it may have pieces torn off of it. If there is any doubt whether or not all the original weight is in the recovered bullet, an X-ray of the wound will show any remaining lead as black irregular splotches. Generally, however, a visual examination will show whether the bullet has actually had particles torn off, or is merely smashed or knocked lop-sided by contact with the bone.

For weighing recovered bullets, etc., a sensitive scale weighing to within a quarter of a grain is necessary. An inexpensive scale that is accurate to more than the required degree is the "Pacific" Bullet and Powder Scale, made by the Pacific Gun Sight Co., 355 Hayes St., San Francisco, Calif. It retails for $7.00 complete with weights. A scale of higher grade is the Voland "Pulp Balance," Catalog No. 1053, made by Voland & Sons, of New Rochelle, N. Y. They sell for $22.00 without cabinet, or $34.00 in a mahogany framed glass cabinet with sliding front. An instrument of this precision should be protected from dust, and I would recommend that the scale with the cabinet be purchased.

Graduated Steel Rule

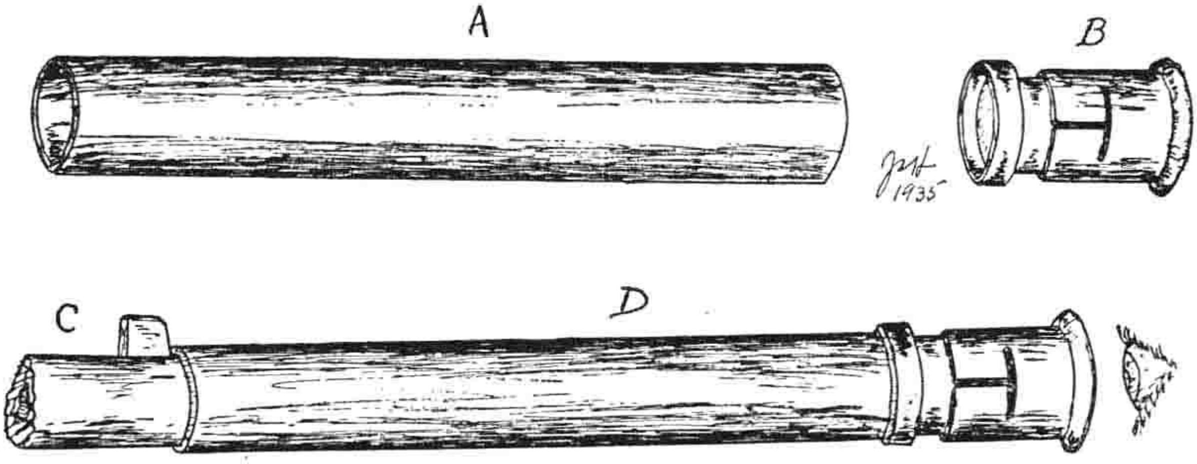
For various miscellaneous measurements where extreme accuracy is not required, a steel rule graduated in hundredths of an inch is very satisfactory for use with the hand magnifier. Starrett's flexible steel rule No. 321 exactly fills the bill.

Taper Gauge

For quickly determining the diameter of the bore of a rifle or pistol, it is convenient to have on hand Starrett's taper gauge, No. 269A, costing $5.50. This has a number of blades, tapering in width, and graduated from an eighth of an inch to ½ inch, by thousandths. This instrument is chiefly useful for giving a quick idea as to the caliber of a gun. Simply insert the appropriate blade into the muzzle of the gun, and read the diameter at the muzzle.

Magnet

A magnet, such as may be obtained from any toy store, or from an old radio loud speaker should be available, for the purpose of testing jacketed bullets to see if the jacket is of cupro-nickel or gilding metal, which is non-magnetic, or is of steel, which will be attracted by the magnet. A steel jacket indicates that the bullet is of foreign manufacture, as steel jackets are not used in American manufacturing practice.



IMPROVISED BARREL TELESCOPE.

A—Brass tube, 8 inches long and ¾ inch outside diameter. B—Bausch & Lomb "Telefier" or pocket telescope magnifier. The front flange of this little telescope fits neatly over the outside of the brass tube, as shown at D. C—Barrel of gun, showing barrel telescope slipped over the muzzle for observation of the interior. By drawing the two parts of the "Telefier" apart or pushing them together, the focus may be adjusted for any desired part of the inside of the barrel, and by slanting the instrument to one side or the other, as shown in the lower sketch, the sides of the bore may be brought into view as desired.

Barrel Telescope

It is often necessary to make a visual inspection of the inside of a gun or pistol barrel to see, for example, whether or not it shows signs of having been fired recently, to look for leading or metal fouling, to see how distinct the lands and grooves appear, how much wear or erosion appears, or for many other purposes.

The portion of the bore near the muzzle can be seen fairly well with the naked eye, but the parts that are farther away can naturally be seen less clearly. In order to overcome this difficulty, the author thought to utilize a short focus telescope or a long focus magnifier, which is about the same thing, so he obtained a couple of lenses and fitted them up for this purpose, and made a very successful barrel telescope, which could be adjusted so as to focus on any part of the bore desired.

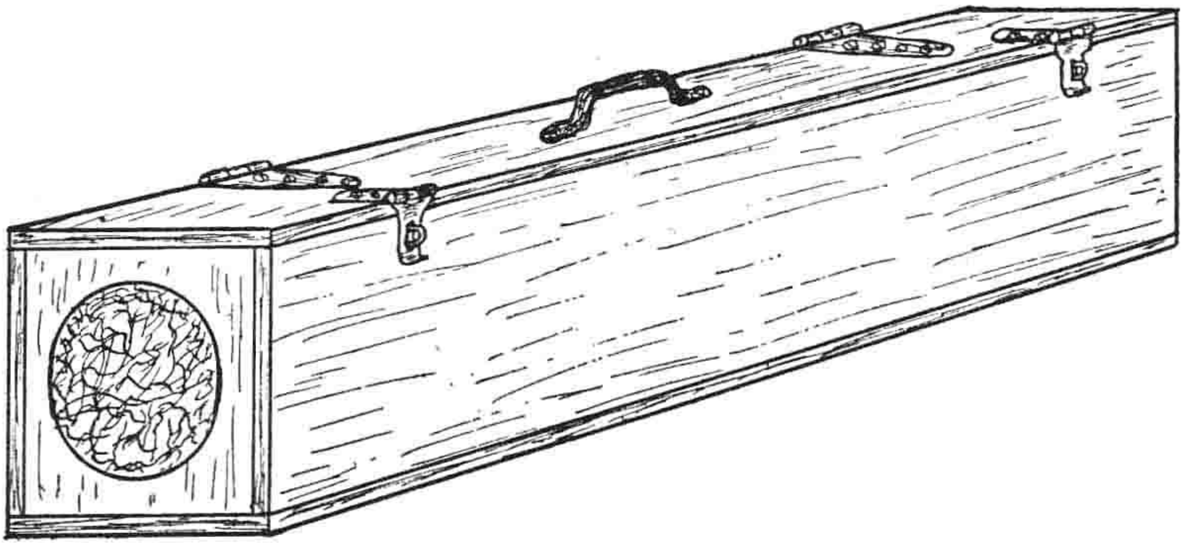
Recently a pocket telescope has appeared on the market which will save the reader the trouble of figuring out such a combination for himself, for it can very well be used for the construction of an excellent barrel examining telescope. This is the "Telefier" sold by Bausch & Lomb for $3.75. It is a small pocket telescope-magnifier which is indeed a wonderful value for the price, and a most useful instrument to have, aside from the special use to be described. It has two lenses in a sliding mount, and when they are together, they form a telescope; but when they are separated by simply pulling them apart, the front lens forms an excellent magnifier with a power of 6x. When the instrument is used as a telescope, it can be focussed for any distance from infinity to eight inches, by simply separating the two lenses, or pushing them together in their sliding mount. This little device is just a little over an inch long, and ⅞ of an inch in diameter. It comes complete in a small leather case.

The fact that as a telescope it can be focussed for very short distances is what makes it useful for a barrel examining telescope. To adapt it to this use, the author simply cut off a piece eight inches long from a brass tube ¾ inch in outside diameter. This fits snugly into the front flange of the little telescope. To look at a gun barrel, the far end of this tube is slipped over the end of the gun-barrel, and comes to rest against the base of the front sight. The telescope can then be focussed for any desired portion of the barrel by simply pulling the eye-lens out or pushing it in. By tipping the instrument one way or the other, using the front sight as a fulcrum, various sides of the bore can be brought plainly into view.

Bullet Recovery Box

For either elementary or advanced firearms identification it frequently becomes desirable or necessary to obtain a bullet which is known to have been fired from a given weapon. For example, a bullet is found at the scene of the crime and a suspect is found to own a weapon of the same caliber. Obviously one of the first things to do even in elementary investigation is to determine whether or not the fatal bullet could have come from the weapon in question. This task is greatly facilitated by having a sample bullet known to have been fired from the suspected gun. Then the two can be compared, and it can easily be told whether or not the marks left by the lands and grooves are of about the same width, whether the number of grooves is the same or different, whether the twist of rifling is the same and etc. If any one of these general characteristics is different on the two bullets it is certain that the exhibit bullet did not come from the suspected gun. If, on the other hand, the bullets appear alike in every particular, it becomes a job for an advanced expert with the comparison microscope.

Bullets fired from a suspected gun may easily be recovered undeformed by one of several methods. A bank of newly fallen snow, if it is of sufficient thickness will stop any bullet fired into it without deforming the bullet in the slightest. However, snow is not often available when needed, and the bullet is hard to find. A method which has been much used in the past by certain investigators is to fire the bullet into a box loosely filled with oiled saw dust. The saw dust should be from a soft wood and should be fine in granulation. With this method care must be used that the sawdust does not become damp or packed as in this case the bullet is likely to go all the way through. All of the methods used above have their drawbacks and as a practical solution perhaps the most satisfactory is to stop the bullet in cotton waste. A box or trough four feet long filled loosely with cotton waste will stop any pistol or revolver bullet. When the bullet first plows into the cotton waste some of the fibers stick to it and as it rotates it gradually wraps



PORTABLE BULLET RECOVERY BOX

This handy accessory consists of a box about 8 to 10 inches square and 4 feet long, with a hinged lid, and an opening in one end, as shown. When filled with fine cotton waste, packed loosely in place, it will stop any pistol bullet. Naturally, it should be used with due precautions against accident, for there is always the chance that a bullet may either go all the way through, or else pierce the sides or top. This is particularly true if the marksmanship of the investigator is not sufficiently accurate to place the shot in the center of the opening, and with the line of flight parallel with the axis. Therefore it is well to have the device backed up by some suitable backstop. After firing a bullet into the box, the lid is thrown back and the bullet is recovered from the waste.

itself into a tight ball of cotton which it carries along with it. This ball of cotton being dragged through the mass of waste acts as a brake which gradually brings the bullet to rest in a short space.

Such a box is best constructed of four boards from eight to ten inches wide and four feet long, three of which are nailed together to form a trough with the top left open. The fourth board is simply laid on top. The front end of the trough is left open, while a square plank is nailed over the far end so as to close it.

To use this box it should be placed in such a position that if a bullet should by accident go all the way through, it will do no harm. For example, the box might be set on a bench in the basement with the end against the brick wall. Then, standing six or eight feet away from the box, the user fires a shot into the center of the box so that the bullet will strike the exposed cotton waste about in the center and so that its path will be parallel to the sides of the box.

If the aim is poor and the direction is bad so that the bullet goes through the waste on an angle, it will strike either the sides, bottom, or top; but as the angle at which it strikes any of these interior surfaces will be slight, it will be deflected back into the mass of cotton. Naturally it is highly desirable to avoid having the bullet strike any of the boards as described above, for this would deform the bullet somewhat, which is undesirable. In fact, unless the box is to be used in some safe place such as a closed basement, and only by expert shots, it is a desirable precaution to sheath the box with metal.

After the shot is fired the location of the bullet in the cotton can be determined by feeling through until a lump is discovered. Locating the bullets in the cotton is facilitated if several vertical partitions of cardboard are inserted in the cotton so as to divide it into sections. By lifting these pieces of cardboard out after firing, it can be determined approximately how far the cardboard has gone, and the bullet can be more easily located. Always place the box in such a location that safety will be assured if a bullet should pierce one of the sides or should escape under the cover. I have never had this happen, but one can never be too careful.

INSTRUMENTS USED IN ADVANCED FIREARMS IDENTIFICATION

The advanced worker should of course have all the tools and instruments that have been described already, and in addition he should have several other pieces of apparatus, some of which are highly complicated and very expensive and most of which require a considerable degree of scientific training and experience for their use. These are listed below:

Microscopes

It is desirable to have not only one microscope but several. In addition to the ordinary microscope, which is used merely for looking at magnified objects, a special form of this instrument called the Comparison Microscope is indispensible for bullet identification; and in addition there are several attachments to the microscope which must be on hand. These will be described in turn.

A compound microscope always has two sets of lenses, one of which screws on to the bottom part of the microscope tube near the object to be viewed and is called the "objective lens" or "objective." The other is called the "eye-piece" or "ocular" and fits into the top of the microscope tube nearest to the eye of the observer. Objective lenses are listed in the catalogue by the equivalent focus in millimeters or by the magnifying power. All modern objectives are marked plainly with the magnifying power. Modern oculars are listed in the catalogue by the magnification and are so marked. The final magnification of the instrument is found by multiplying together the magnifying power marked on the ocular and that marked on the objective. Thus a ten power ocular when used with a forty-eight millimeter objective, having a magnifying power of 2.2, will give an overall magnification of 22. This combination is frequently used in bullet work.

The body of the microscope consists of a draw tube arranged to hold the objective on the bottom and the ocular in the top. The tube is arranged to pull out like a telescope and there is a series of numbers engraved on the inside sliding tube to indicate the tube length. Modern objectives are corrected to give the best image with a tube length of 160 millimeters and the microscope should always be set to this length when using it. It should be noted that the magnification marked on the lenses is for this tube length only as a longer tube length increases the magnification and a shorter one diminishes it.

The Stage

Under the body of the microscope, there is a platform for the object to rest on. This is called the stage. Some stages have a movable holder for the object, and this holder has two motions, one backwards and forwards, and the other from side to side. The motions are made with the aid of a rack and pinion arrangement, with knobs to turn. This device is called the mechanical stage, and by its means, very small motions of the object can be made with precision. This is important, because with the magnification accomplished by the microscope magnifies the motion of the object as well as the object itself, and very small motions of the hand seem large when viewed through the instrument. For this reason, often very minute motions of the object are required to bring it to the required new position, and by means of the mechanical stage, this motion may be accomplished with precision, as the motion of the adjusting knobs is reduced through the action of the rack and pinion.

The slides of the mechanical stage usually have graduations on them, marked in millimeters, with a vernier reading to one-tenth of a millimeter, or four-thousandths of an inch. The reason for these graduations is to enable a given object, for example, in a preparation on a glass slide, to be noted for future examination by having its location noted in readings of the stage graduations. However, it is very useful in bullet work for making measurements of such things as the length of bullets or cartridge cases, etc., using an eyepiece with a cross-hair in it. For this reason the stage of the comparison microscope should have the graduations on them.

Magnification

The ordinary microscope as found in most laboratories magnifies from about 15 diameters up to about 1500 or more. Most people who are inexperienced in the use of these instruments think that the higher is the power the more the user can see. This idea is entirely erroneous. The power which is most effective depends very largely on the subject under observation and what it is desired to observe.

The higher the power the closer must be the lens to the object under observation and the smaller will be the field of view. Thus with high powered lenses, the outline of the object is lost and only the smallest portion of the surface is seen. Moreover, only that portion of the surface can be seen which happens to be at that distance from the object lens which is correct to bring it into focus, for with high powered lenses the depth of focus is small and only an extremely small motion of the lens will throw the object out of focus and make it disappear. In other words the depth of focus varies with the power, becoming smaller as the power increases, and with even moderately high powers there is such small depth of focus that if there are depressions or irregularities in the surface, only the tops of the ridges or the bottoms of the depressions will be seen, depending on whether the instrument is focused on the tops or on the bottoms of the irregularities. However, as the power becomes lower a greater depth can be seen, so that with a moderate power, both the tops and bottoms of the depressions can be seen at one time.

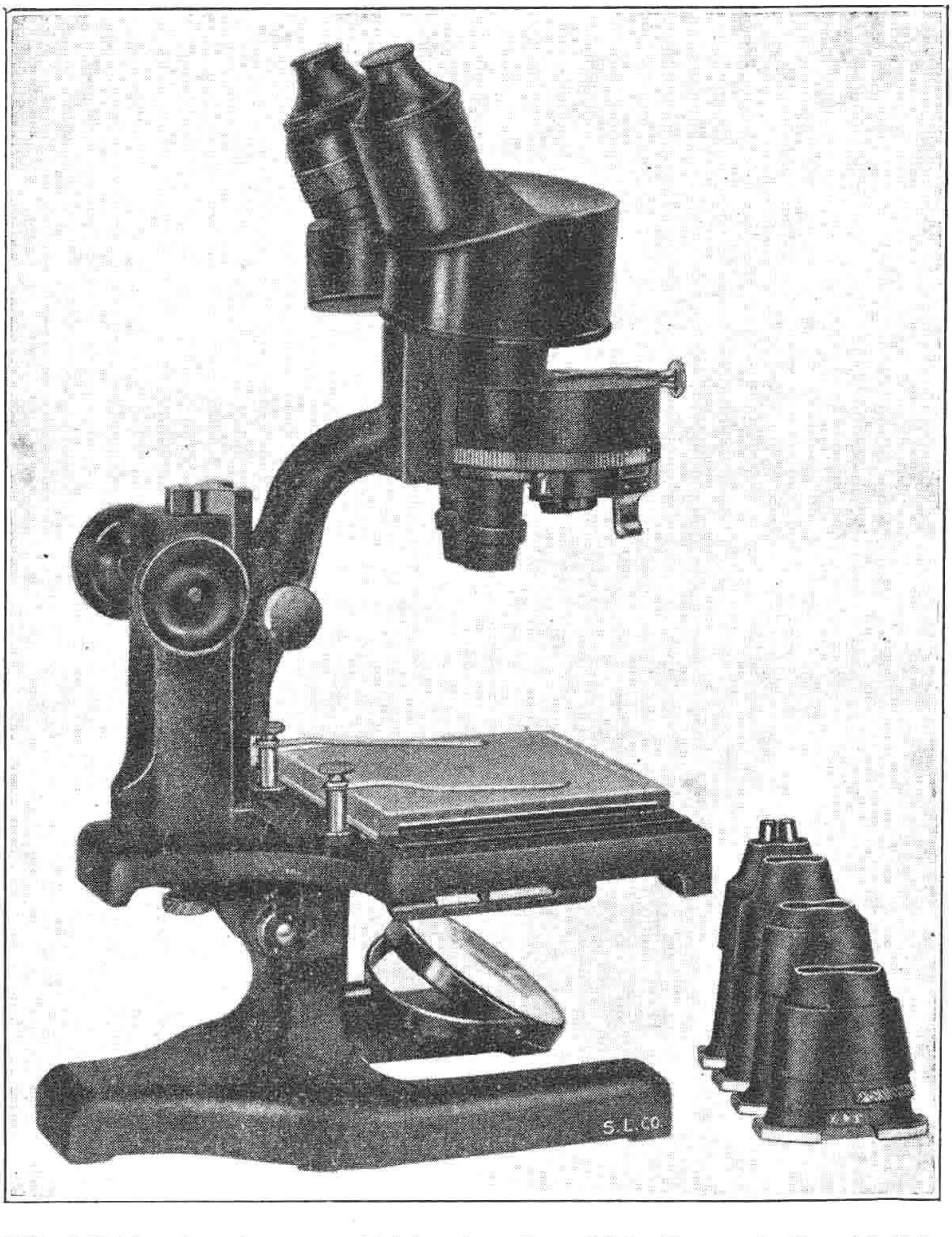
Another disadvantage of the higher powers is the fact that it is difficult to light an object that must be placed only a few thousandths of an inch away. For this reason, powers higher than about 100 diameters are used mostly for the examination of transparent objects mounted on glass slides, in which case the illumination is accomplished by throwing the light up through the glass by means of a mirror or condenser under the stage of the instrument. On very flat surfaces, such as a polished metal specimen, the illumination with the high powers may be accomplished by means of a special device, called a "vertical illuminator" which throws a beam of light down through the objective itself. However, the bullet is neither transparent nor flat, and even if the bullet could be illuminated for examination under the high powers, it would be useless for our purposes, as all that would be seen would be a very small portion of the surface very highly magnified, with nothing to compare it with.

Wide Field Binocular Microscope

The ordinary microscope inverts the image of the object, and this is often confusing. There is, however, a type of prismatic binocular microscope, which shows objects right-side up, and moreover, has two eye-pieces and objectives, so that objects under examination are seen with stereoscopic vision and in true perspective. This is the Greenough type binocular miscroscope. It is best adapted to low power work, and the objectives and eye-pieces usually furnished with such an outfit will allow the use of powers from six diameters to 84 diameters, though higher or lower powers can be had if desired.

An excellent instrument of this type is the Spencer wide-field universal binocular miscroscope No. 55LT. This is fitted with three objective lenses, giving magnifications of 1.0, 1.7, and 2.3 diameters, respectively, and with three pairs of eye-pieces of 6, 12.5, and 17 power. The magnifications thus made available are

6, 10.2, 12.5, 13.8, 17, 21.2, 28.6, 28.9, and 39.1 diameters. Such a microscope is one of the most convenient instruments that it is possible to have around an identification bureau. It is useful for a thousand and one purposes, such as viewing powders, ink marks, handwriting, dust or any small objects whatever that may have



Wide-field binocular microscope, which is extremely useful for the examination of bullets, powders, cartridge cases, handwriting, etc. This instrument not only allows the use of both eyes, but it gives a stereoscopic effect which enables the depth of depressions and scratches to be seen, and gives specimens under examination a very pleasing appearance of reality, which is of great assistance in judging what is seen.

been collected in connection with the investigation, etc. It has the great advantage that the comparatively low power and the binocular stereoscopic vision allow things to be seen with a natural appearance so that they can be recognized. They appear merely as natural objects very much enlarged, instead of looking like an entirely unfamiliar picture, as do the things seen through a high powered single tube microscope of the laboratory type. The author has for years done microscopy of all kinds, and has available microscopes of various kinds, ranging in power from 6 to 1500 diameters, all of which have been used on occasion; but he has no hesitation in saying that for general use the wide field prismatic binocular is far and away the most useful. This is particularly true where the user has not had extensive laboratory training and experience in the use of microscopes.

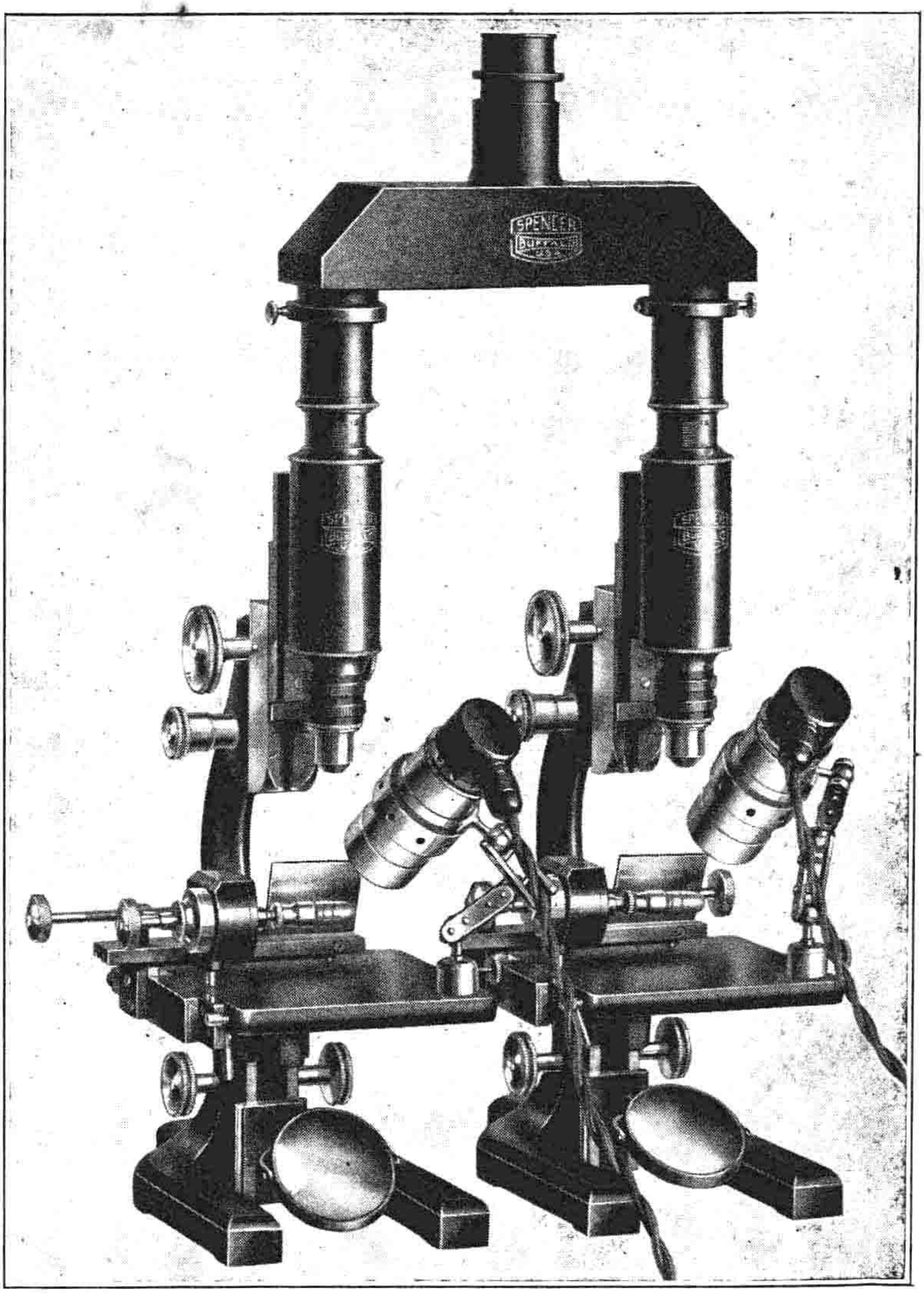
With any such outfit it is absolutely necessary to have some dependable and uniform source of illumination. A small lamp specially made for this use is the Bausch & Lomb Universal Microscope Lamp, catalog No. 1808, which at the present writing lists for $3.50.

A much more satisfactory lamp is Spencer Microscope Lamp No. 370, costing $25.00, or a similar lamp made by Bausch & Lomb. This lamp has an iris diaphragm of its own for controlling the intensity of the illumination. It is part of the standard Comparison microscope outfit, and therefore will not have to be purchased separately for use with the wide field binocular if a comparison microscope is to be obtained also.

Comparison Microscope

This instrument is used in firearms investigations to determine definitely whether a bullet or cartridge case connected with a shooting affair was or was not fired from a particular individual gun. To make this determination, the expert compares the evidence bullet, or the evidence cartridge case, with a similar bullet or cartridge case fired in the suspected gun, called the "test" bullet or cartridge case. Test bullets are obtained by firing them into cotton waste in the bullet recovery box already described.

The object of the comparison microscope is to determine whether or not both evidence cartridge case and test cartridge case have *exactly* the same markings impressed on them by their impact against the breech face of the arm, or if both bullets have *exactly* the same scratches and marks on them from their passage over the irregularities in the barrel of the gun. The interior of every gun barrel has certain small scratches, marks, and irregularities left by the tools that machined the surface, and even if there is some large flaw in a reamer or rifling cutter that might make similar marks in several guns, the tearing of the surface as



Spencer Comparison Microscope set up with two bullets in place for examination. Note the individual lights and the reflectors for controlling the illumination.

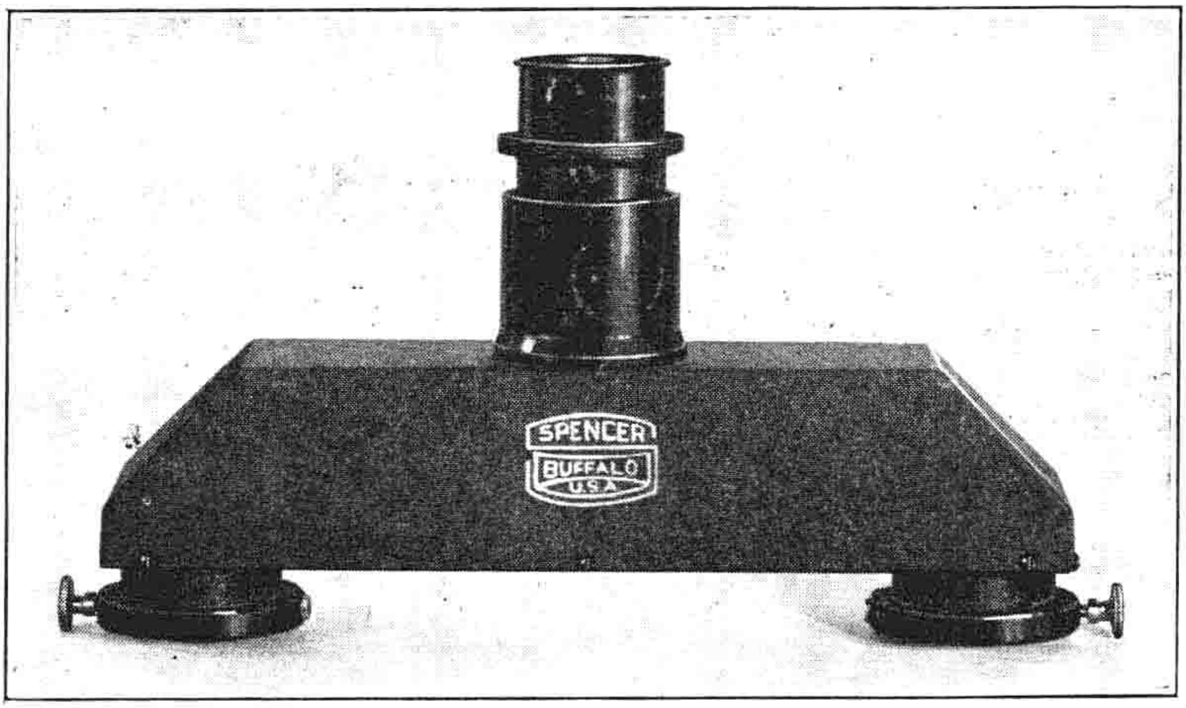
machining progresses will produce an ever changing secondary pattern that will not be duplicated, and that will enable the expert to separate and correctly identify bullets from two barrels made in succession with the same tools, as has been proven by test.

With a fatal bullet and a test bullet at hand, the investigator makes use of the comparison microscope, which is nothing more than two laboratory type microscopes, mounted on a stand side by side, and fitted with a special comparison eye-piece. This comparison eye-piece is a sort of bridge which fits onto the eyepieces of both microscopes, and extends across the space between them. In the middle it has a single eye-piece of its own.

By a system of lenses and prisms the comparison eye-piece takes half the image from the right hand microscope and the other half from the left-hand microscope and combines them in the one eye-piece of its own. Thus if the two bullets are mounted under the objectives of the two microscopes forming the instrument, the operator, looking into the single eye-piece in the middle of the bridge sees what appears to be one bullet; but it is made up of half of the image of the right hand bullet and half of the image of the left hand bullet. Thus the operator is enabled to see the two bullets side by side; or rather, to apparently see the two bullets sliced in two and the cut parts placed together. This enables an extremely critical comparison to be made, and differences in the width and shape of the lands and grooves, etc., are readily apparent.

It should be particularly noted that the comparison eye-piece used with the bullet identification outfit contains prisms which bring the image right-side up again after it has been inverted by the two microscopes. One thing that often confuses the beginner in microscopy is the fact that the ordinary microscope shows everything upside down and backwards. Every motion of the object under the lens in making adjustments must thus be reversed, which is difficult for the beginner. Moreover, there would be some chance of confusing the test bullet with the fatal bullet. Fortunately the comparison eye-piece removes all this confusion and enables the user of the bullet identification to see everything right side up and in its proper position, and also makes the motion of the image follow that of the bullet when adjustments are being made.

It should be understood that while the comparison eye-piece brings the two images together into one, the two halves are separated by a fine division line, which is very necessary for several reasons. In the first place, it shows definitely where one image leaves off and the other begins. Then, too, in photographs that are to be submitted for evidence, it clearly indicates that there are two separate images involved, and adds an atmosphere of straightforwardness that will have a tendency to remove any suspicion on the part of the jury that an attempt is being made to make things look too perfect, as is sometimes the case when the two halves of a matched photograph are too perfectly blended. The comparison eye-piece is equipped with a focusing collar that permits a sharp focus on this dividing line, and this matter of focusing the line sharply should not be neglected. This should be done before the final focusing on the object is accomplished.



The Spencer Comparison Ocular. This instrument fits over the eye-pieces of two ordinary microscopes and brings half the image from each instrument to the central eye-piece, where the two halves are seen side by side so that a searching comparison is possible.

As there are two separate microscopes, with the comparison eyepiece lying like a bridge from one to the other, it is rather inconvenient to focus the individual microscopes separately by raising or lowering the body of the instrument, as is commonly done when using a microscope alone, for the motion of raising either microscope separately will raise that end of the comparison eyepiece also, and this motion of raising one end of it without raising the other will tip it and throw it out of level. For that reason, the most elaborate comparison microscopes are arranged so that when the two microscopes are once adjusted to bring the comparison bridge level, they may be left that way, and the focusing may be accomplished by raising or lowering the stages, which are provided with a vertical adjustment by means of a focusing knob.

The best magnification for bullet or cartridge work under the comparison microscope is from 12 to 25 diameters, and the ordinary equipment of the instruments furnished by the Spencer Lens Company includes a pair of matched objectives of 48 millimeters focal length, giving an initial magnification of 2.2 diameters, and two matched pairs of eye-pieces, one of 6 and the other of 10 power, thus giving a total magnification of either 13.2 or 22 diameters. The lower figure is more suitable for visual examination, and the higher for photography.

There are usually some slight differences between any two objectives or eye-pieces, even if they are marked the same, and it is essential that the two images should be magnified exactly the same, it is usual to have the two objectives and the two eye-pieces *matched* by the maker. In other words, he picks out of his stock, by means of tests that he has available, two objectives that are identical in every way, and that give exactly the same magnification; and he does the same for the eye-pieces.

It is useful to know that the U. S. Bureau of Standards at Washington will examine lenses intended for this purpose which are submitted to them and will give a certificate that they are properly matched. This is often useful as tending to help establish the fact that the instruments used can be relied on to give authoritative results.

In making comparisons, the operator must be careful to have both microscopes adjusted the same. A failure to do this may result in different magnifications being given by the two instruments, and will nullify the most careful matching of lenses. Each microscope has a draw-tube graduated in millimeters, and a tube length of 160 millimeters is necessary to give the magnification marked on the lenses. The draw tubes should be kept adjusted to this length at all times. Moreover, the body of each instrument should be raised to precisely the same height above the stage, and left there. In this way both eye-pieces, on which the comparison ocular rests will be at the same height, and the bridge will be level. It is well to make a mark on the sliding part of the frame to indicate this proper height.

Bullet Holder

Under the objective lens of each microscope is the bullet holder. As already mentioned there are two kinds of stage in common use, the plain stage, which is just an ordinary platform, and the mechanical stage, which is the same platform fitted with a sliding part on top arranged to be moved by means of two racks and pinions, one of which gives motion to one side or the other, and the other of which gives motion forward and backward. The motion in each direction is controlled by a knob with a knurled head, and by using this knob, extremely delicate motions or changes in position of the object can be made with precision.

The ordinary mechanical stage is intended for use with glass slides, and is fitted to hold them; but on the comparison microscope used in ballistic work, the case is different, as the object to be handled is the bullet or the shell, and moreover, the bullet must be held so that it can be turned so as to bring every part under examination. For this use the Spencer Lens Company have designed special mechanical stages with bullet holders mounted on them. The bullet holder consists essentially of a spindle with a detachable cylindrical head to it, which is about the same diameter as the bullet to be tested. To accommodate the various sizes of bullet, the Spencer outfits have four sizes of holders, one size being for .22 caliber bullets, and the others for .32, .38, and .45 calibers, respectively. Bullets of other calibers will be close enough to one of these four sizes to be accommodated satisfactorily by the set of holders nearest to the bullet in diameter.

These holders are furnished in pairs, one for use under each side of the comparison microscope, and there are two sets in each size, one set being arranged for use with bullets having the marks of six-grooved rifling, and the other for bullets having five grooves. The holders have index lines engraved on the outer surface to correspond to the position of the grooves on the surface of the bullet, and these index marks are numbered from one to five, or from one to six, so that each land or groove of the bullet on that holder is identified by a number, as long as the bullet remains in the same position on the holder. There are also two sets of numbered drums furnished to slip on the spindles near the handles that are used for turning them, and these are also numbered, one set for five grooved bullets, and the other for six grooved ones.

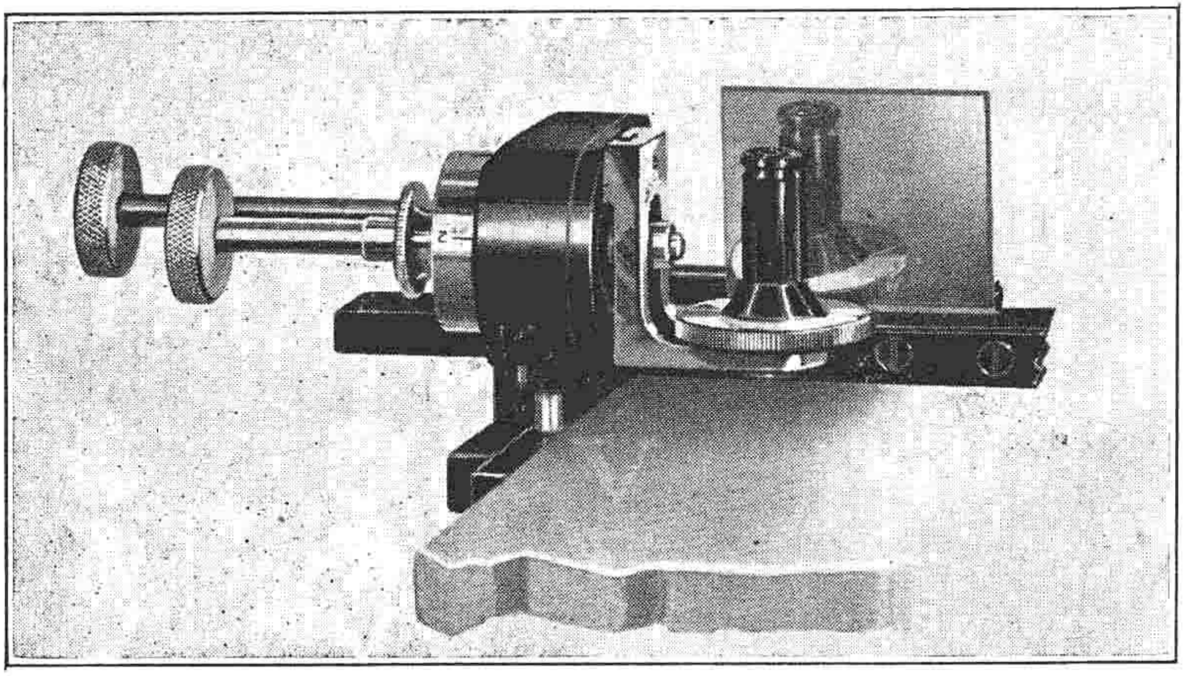
The bullets are held onto the spindles by the simple procedure of sticking them on with some plastic or adhesive substance. Ordinary modeler's clay, is sold under various trade names, such as Plasticene, Plastique, Plastene, etc., is used for this purpose. This material is a clay in which cocoa-butter is used as a solvent or mixer, in order to prevent the material from hardening. As cocoa-butter will not dissolve, the clay never hardens. It is quite corrosive on either bullets or brass cartridge cases, and should be wiped off after the examination is all completed. It is useful to know that any cleaning fluid, such as is sold for taking grease spots from garments will dissolve cocoa-butter, and therefore can be used to remove the last traces of modelling clay from bullets, bullet holders, or any other objects or instruments on which it may have become smeared.

In preparing for an examination, the fatal bullet is stuck onto one spindle and the test bullet onto the other, with a raised portion corresponding to a groove of the rifling on each bullet matched to the index marks described above. Naturally the number of lands and grooves on the bullets must be counted and the proper spindle with either five or six groove markings, as the case may be, must be selected.

After the bullets have been suitably illuminated and the instrument has been focused, the knobs of the mechanical stage are turned until the bullets are properly in the field of view, and lined up with each other, so that half of the picture is composed of one bullet, and half is composed of the other. Then, starting with No. 1 groove on each bullet, that one is held still and the other one is turned, trying all the time to find a position where every marking on one seems to be continued on the other. When this point is reached, the bullet which is being turned is grasped with the fingers, and held firmly in place, and the spindle is turned until No. 1 mark is indexed with the groove that is uppermost. We now have No. 1 groove of both the Test and the Fatal bullets matched up. Next, the bullets are both rotated together until No. 2 groove on each bullet is uppermost. In this position, all marks should again match, and so all the way round.

Here is where the utility of the numbered drums comes in. Often it will be desired to demonstrate that the bullets match at various places, but an attitude of suspicion may frequently be encountered. The observer may readily agree that the bullets match when first viewed; but after they are turned, he may refuse to believe that the expert really moved them. Such an attitude is prevented by first pointing to the drum and stating that the groove No. 1 will be examined. After a match is admitted, the operator will then state that groove No. 2 will next be examined, and he then turns both drums until the numeral 2 is uppermost. Again the lines will match. He can proceed in the same way to No. 3, 4, etc., and all doubt that he really moved the bullets will be prevented.

It frequently is necessary or desirable to examine cartridge cases with the comparison microscope. The parts most suitable for comparison are the heads of the cartridges and the primers, and for such an examination the cartridges are held with the flat surface of the heads uppermost. Sometimes the cases are mounted on little cones, but this method is often troublesome, as most likely the cartridges will be found to be bent out of shape at the mouth, either by the action of the automatic pistol in the operation of ejection, or from some accident, such as being stepped on. However, the head of the cartridge is strong and thick, and not much subject to distortion through any such cause, so that the most practical holder is one that will grasp the case just under the rim, if it is a rim case, or in the groove around the head if it is a rimless or semi-rim case. Someone finally thought of the simple but effective expedient of using an iris diaphragm, such as is used on cameras and microscopes. The diaphragm can be opened



One form of holder for holding an empty shell under the comparison microscope for examination. Another type is simply an iris diaphragm which is arranged to grasp the case under the rim or in the extractor groove.

up large enough to admit the head of the case, and then closed in to fit under the rim or into the groove. Holders made on this principle are furnished by the Spencer Lens Co. with their outfits for bullet identification.

In examining cartridge cases under the comparison microscope, we are dealing usually with a bright metal surface which reflects light very efficiently, and with the same amount of illumination that is used for bullet examination, all detail will often be lost in a glare of light. To control this condition, the comparison microscope should have iris diaphragms fitted just above the objective lenses. By partially closing these diaphragms, the detail can often be brought out in a remarkable manner. Moreover, when the diaphragm is partly closed, the depth of focus is increased and the image sharpened up.

The illumination of the bullet or other object is most important. Each miscroscope must have its own light, for bullets oxidize differently, and it is not uncommon to find the fatal bullet considerably darker in color than the test. By adjusting the intensity of the individual lamps to suit the color of each bullet, the appearance of the bullets as to brightness can be matched up, and this helps a lot in making comparisons as well as in photographing.

Some experts consider it desirable to lighten up the fatal bullet by dropping it in ammonia for a few minutes; but others prefer not to do this for fear it might be considered as changing the evidence, though such a contention seems very far fetched, as the ammonia does not change the bullet in any way except to restore its original color, which is continually becoming darker with the passage of time.

The earlier Spencer Comparison Microscopes have individual lamps, Spencer No. 358, mounted on the edge of each stage, but the later ones are regularly equipped with two separate lamps of a much preferable kind, known as Spencer Microscope Lamp No. 370, which are not clamped onto the edge of the microscope stage, but have separate stands of their own. They have blue glass and ground glass for diffusing the illumination, and iris diaphragms for controlling the intensity of the light. They can be used for other things besides illumination of the objects under the microscope, as for example, the lighting of bullets being photographed by the camera and short focus lens, as will be described below.

The proper adjustment of the lamps will have a most important effect on the definition obtained. Usually it is advantageous to employ very oblique illumination, and sometimes the rays will have to be directed almost parallel to the surface in examining the heads of cartridge cases, etc. The operator should experiment with this subject, as the best results cannot be obtained in any other way.

Photomicrographic ~~Camera~~

With the comparison microscope the investigator may or may not find that the fatal bullet matches the test bullet. If it does, he has visual proof of it, but this proof will no longer be available after he takes the bullet out from under the lens, unless he takes the precaution to *photograph* what he has seen through the microscope. This matter of photographing through a microscope is common laboratory practice, and is called *Photomicrography.* All that it requires in addition to the apparatus that we have already described is a camera with a holder to retain it in a vertical position over the eye-piece of the microscope; or if a comparison microscope is being used, over the eye-piece of the comparator.

When a camera is used in this ~~manner~~, for photographing through a microscope, the camera lens is removed, for in this case the objective and the eye piece of the microscope take the place of the camera lens. With any microscope an image of the object viewed can be projected on to any white surface such as, for example, the ceiling over the microscope. Of course, in such a case as this, where an image is projected on to a screen a very strong illumination of the object under the microscope must be used and this would be rather hard to do satisfactorily in the case of dull colored objects such as bullets; but the image projected on to the plate of the camera is plenty bright enough to photograph when even moderate illuminations are used, because if the illumination is dull a longer exposure can be given to compensate for the lack of brilliance in the picture. Thus photography can be accomplished when the projected image is not brightly enough illuminated to be satisfactory for visual examination.

All microscope makers such as the Bausch & Lomb Optical Company, The Spencer Lens Company and others make cameras specially mounted for use with the microscope. These cameras are mounted on a vertical post attached to a base plate for holding the microscope. The camera is mounted in a vertical position and is so arranged that it can be placed directly over the microscope or can be swung to one side to allow the microscope to be focused by eye. In addition some cameras furnished for this purpose have an eye piece of their own sticking out at right angles from the shutter housing so that the image in the microscope can be viewed by eye without removing the camera from its position over the microscope.

In order to take a picture through the microscope it is only necessary to set up the object under the microscope, adjust the illumination, and then focus the instrument until the field of view and the appearance of the object are satisfactory. Then the camera is swung over the microscope and the shutter is opened. An image will now be projected on to the ground glass plate in the back of the camera, and this image may be viewed by looking at the ground glass plate the same as is done in taking an ordinary photograph. Usually the image will be very dim and it will be necessary for the operator to place a black cloth over his head in order to shut out extraneous light and render the subject clearly visible. The object should then be brought into sharp focus by moving the stage of the microscope up or down. It is very useful indeed to have at hand a focusing magnifier, which is merely a small magnifying glass in a metal tube which is of the right length to bring the ground glass into focus when the tube is set on top of the ground glass plate. Such a focusing magnifier is furnished by the Bausch & Lomb Optical Company, catalog 4619, at a list price of $5.00.

After the focus has been correctly obtained, the shutter is closed, the plate holder inserted into the camera, and the slide withdrawn. Then the shutter is opened for the required length of time to make the exposure. The length of exposure required is learned only by experience, as it varies considerably, depending on the brightness or darkness of the object, the amount of illumination and the magnification used. The higher the magnification, the more the available light must be spread out and the greater must be the exposure given.

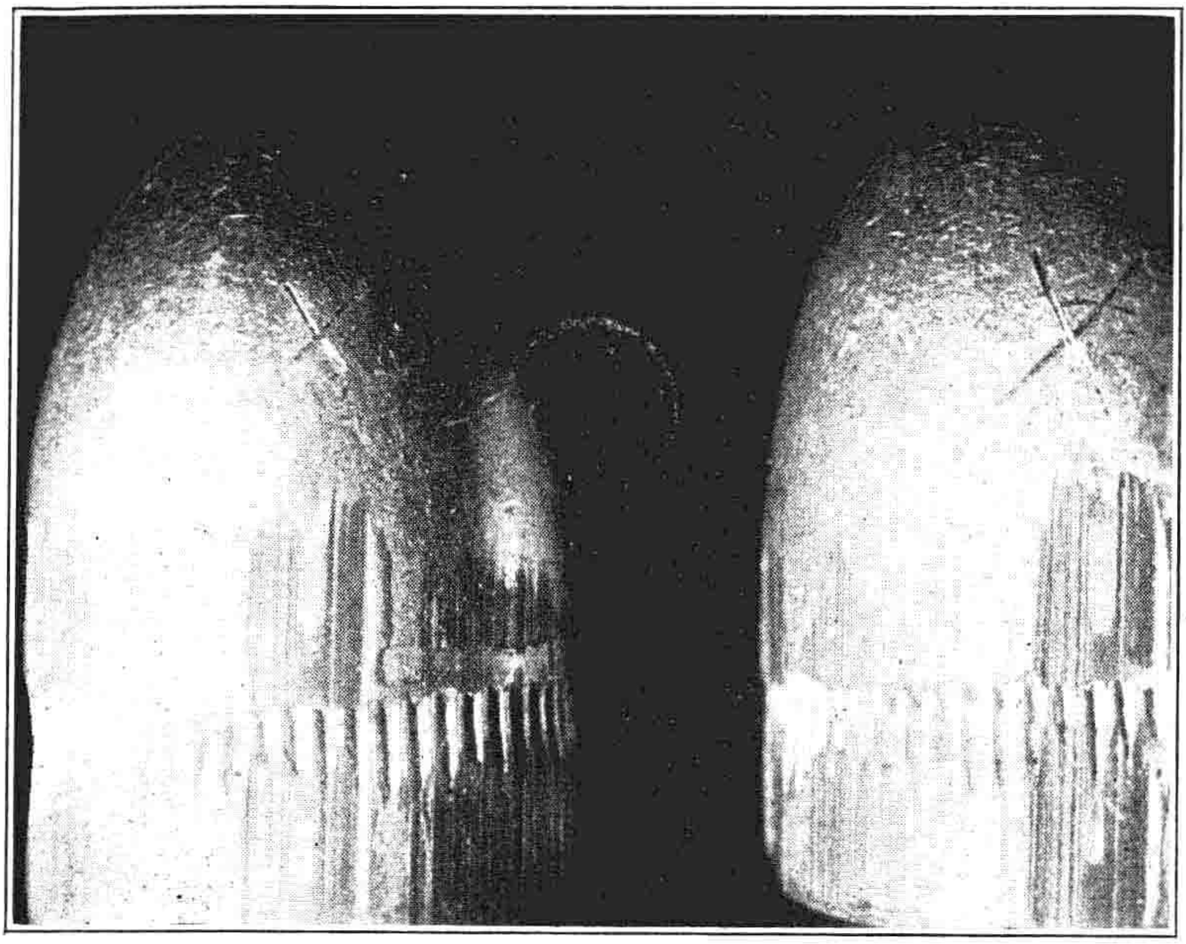
With a camera having an extension bellows the magnification depends not only on the power of the microscope objectives and oculars that are used, but also on the extension of the bellows. The further the plate is from the eye piece the more the image will be spread out and the greater will be the resulting magnification of the picture.

Recently a type of camera with a box of fixed length instead of a bellows is becoming increasingly popular for micrographic work.

Such a type of camera has several very considerable advantages. In the first place it is made of a fixed length of 250 mm., which is the usual distance for clear vision with the unaided human eye, and a picture taken with this camera gives precisely the same magnification as is obtained when the specimen is viewed through the microscope alone. Thus the magnification obtained in the picture can be determined closely enough for all practical purposes merely by multiplying together the magnification of the objective and that of the eye piece used in the microscope. As all modern objectives and eye pieces are plainly marked with the magnification that they give, this makes it extremely simple to know what results are being obtained. An even more important advantage of this camera is the fact that no focusing on the ground glass plate is necessary. Just below the camera shutter there is an eye piece projecting at right angles to the body of the instrument, which enables the specimen to be accurately focused on the plate merely by looking through this eye piece. The view seen through this eye piece is just the same as would be seen when looking down the tube of the microscope, hence it is not necessary to move the camera from above the microscope when making visual examinations. An object under the microscope can be viewed and examined as much as desired and then when it appears correct through the horizontal eye piece the plate holder can be placed in the camera and the picture can be taken without any further focusing. This camera, Spencer No. 645, is highly recommended on account of its convenience, simplicity of operation and uniformity of results.

Photomicrographic Lenses

While we have been referring above to the taking of enlarged photographs through a microscope, the reader should clearly understand that a microscope is by no means necessary for taking enlarged photographs, for pictures with all the magnification necessary for bullet comparison work can be made with no other apparatus than a long bellows camera and a short focus lens. If the lens is placed close up to the object and the camera bellows is extended to the proper point the picture will be much larger than the object. Using a lens of 48 mm. (approximately two inches) focal length, it is possible to take photographs magnified up to as much as twenty diameters. After it has been determined that the test bullet and the fatal bullet match, the corresponding lands and grooves of the fatal bullet and the test bullet should be photographed for comparison. This photographic work is usually done by an ordinary camera without the use of the microscope. For this purpose the investigator will need a special lens known as the Spencer Micro-Teleplat or the Bausch & Lomb Micro-Tessar. These lenses are made in various focal lengths, but 48 mm. is the most suitable for bullet work. They are made to fit on the tube of the microscope, but an adapter should be obtained to enable them to be used directly in the camera shutter. This adapter is regularly furnished by the makers of the lens for a small additional price.



Identical markings on two bullets fired from the same gun. Enlarged photographs such as this one can be made by any ordinary camera which has an extension bellows, such as the Kodak "Recomar" fitted with a supplementary short focus lens which is regularly supplied with this camera at a small additional cost.

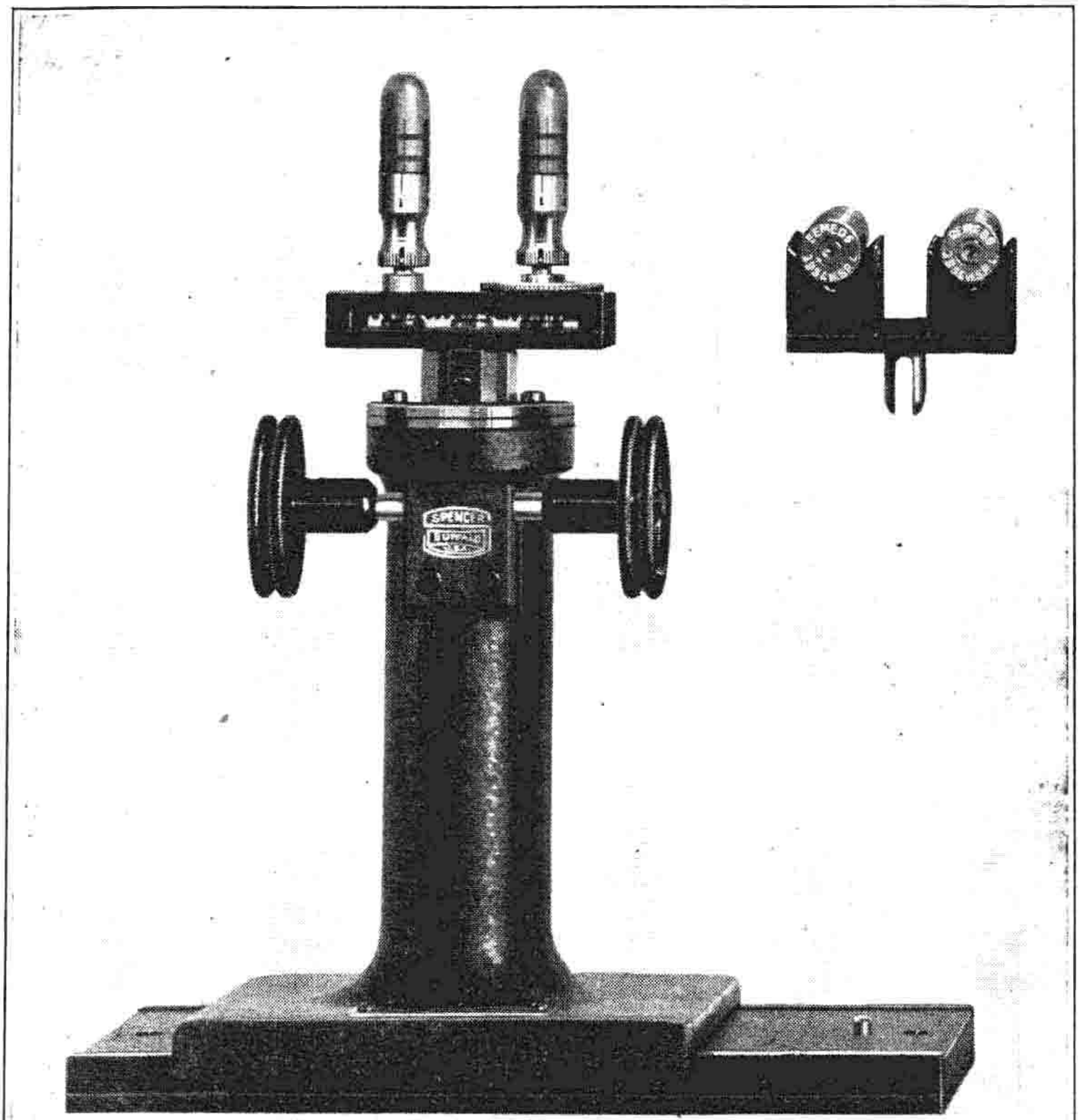
These short focus photographic lenses may be used on the microscope in place of the microscope objective for all the bullet work that has been described. They are more expensive than the ordinary microscope objective, but they have the important advantages of being more finely corrected and of having a diaphragm between the two elements of the lens. A diaphragm is absolutely necessary for good results in bullet photography, because when the diaphragm is closed down to a small opening the depth of focus is increased and the parts of the bullet which are slightly above or below the focal plane can be clearly seen.

Enlarged Photographs

Everyone who has had any experience with picture taking knows that a small photograph may be enlarged to almost any size desired. It is therefore possible to take a small picture of a bullet and enlarge it to the same size that a micro-photograph of it would have. However, the results are far from being the same in this case as they are when a real micro-photograph is taken with either a camera and a short focus lens or with a camera and a compound microscope, as anyone who has studied the subject of microscopy will fully realize. When a micro-photograph is taken, the lens is close enough to the object to separate points which lie very close together, and thus give resolution of detail. When an ordinary photograph is taken the lens is too far away from the object to separate very close points, and enlarging the resulting photograph will not add any new detail. It merely spreads out what is already in the picture, and gives what the microscopist calls "empty magnification." Suppose, as an illustration of how this works, we take a picture of a ship, showing ropes. We may enlarge this picture until the ropes appear as thick as a man's wrist, but we will not see any indication that the rope is composed of fine fibers twisted together. The line representing the rope merely gets wider and wider as we increase the enlargement, but it does not gain detail. On the other hand, if we take a close-up picture of the rope with a lens of say two inch focus, we can show the individual fibers with great clearness. It may be advisable at times to use enlarged photographs for demonstrations, etc., but the difference between an enlargement and a micrograph should be clearly understood.

Bullet and Shell Photo Stand

In making complete photographs of the bullets as referred to above it is extremely convenient to have available a special photographing stand such as Spencer No. 620 illustrated herewith. This stand particularly facilitates the taking of a series of photographs showing identical lands and grooves of the fatal bullet and the test bullet. The procedure is as follows: The bullet holders used with the microscope have either five or six numbered marks engraved around the edge to correspond with the number of lands and grooves in the bullet. To begin with, the test bullet is attached to one of these spindles with one of the raised portions or groove marks on the bullet exactly opposite each one of the engraved lines. The fatal bullet is then attached to the other spindle. The bullets are then placed under the comparison microscope and examined until it is determined whether or not any of the lands and grooves on the two bullets match exactly. If it is found that groove 1 on the test bullet matches some groove, say



Bullet and cartridge photographing stand made by the Spencer Lens Company. The spindles of this instrument are geared together so that when one is turned, the other must turn an equal amount. They are fitted to take the bullet holders used on the comparison microscope, thus facilitating the taking of photographs showing identical surfaces on the fatal and the test bullets. The stand has a sliding motion on its base which is exactly equal to the distance between the two bullet spindles. The right hand bullet is photographed, then the instrument is slid to the right as far as it will go, which brings the left hand bullet into exactly the same position formerly occupied by the other bullet, and assures that the photograph will be taken from an identical point of view.

No. 3, on the fatal bullet, the fatal bullet is then grasped by the fingers and held in position while the spindle is turned until the figure 1 is opposite the groove in question. This is easily done because the bullet is merely held in place by means of an adhesive substance. Now we have arranged the bullet so that all the grooves which are numbered the same on the spindle should match. By turning the spindle until grooves 2 and 2 are uppermost we should also find both grooves matching, and this should be true of every correspondingly numbered set of grooves all the way round.

The spindles with the bullets still on them are now removed from the microscope and mounted on the Spencer Bullet Stand. The two spindles on the bullet stand are geared together so that by turning a knob, the two bullets will rotate at the same speed. They are turned until grooves 1 and 1 are facing the camera.

We are now ready to begin our photography. It should be noted that the bullet stand has a sliding motion to the right and left on its base. It should be pushed to the left as far as it will go and the camera should be set up in front of the right hand bullet and focused on it as carefully as possible, a powerful lamp such as the Spencer No. 370 being used to illuminate the bullet. To bring out the marks and scratches as clearly as possible it will probably be necessary to set the lamp well to one side so that the illumination is quite oblique. In this way the high lights and shadows on the ridges and the scratches between them will make the pattern more plainly visible than it would otherwise be. The bullet is then photographed, the plate removed and a new plate inserted in the camera and then the bullet stand is slid as far as it will go to the right. The motion is controlled by a stop in the base which arrests the motion when the left hand bullet has moved over into the exact position formerly occupied by the right hand one, and it can now be photographed in turn. This completed, the spindles can be turned until the next groove appears, and another photograph can then be taken, and this can be continued all the way around so that corresponding pictures of both bullets showing every corresponding land and groove can thus be made.

Two bullets can be set up side by side, and photographed at the same time, without the use of the bullet photographing stand, as described above, but they will each be at a slightly different angle to the lens, so that the picture will show a little more of the right hand side of the left hand bullet, and a little more of the left side of the right hand bullet. With the stand, this is avoided, and exactly the same view is obtained of each of the two bullets.

This stand is also used to photograph the heads of cartridges in the same way. They are held by simply laying them in two "V" grooves in a block which is mounted on top of the stand in place of the two vertical spindles.

Camera and Tripod

For the direct photography of bullets, just described, it is necessary to have a camera with a ground glass back for focusing, and a long bellows extension. Usually such a camera will already be available in police departments or other organizations who are likely to establish a bullet identification department. Moreover, the photomicrographic camera of the type which has an extension bellows is quite capable of being used for direct photography; it is especially suitable for making photographs of the heads of cartridges by simply setting them up on their ends under the vertical camera. But this camera does not lend itself well to use with the bullet and shell photo stand unless it is of the type that can readily be swung to the horizontal position, or unless it is removed from its vertical standard and placed on a horizontal base.

If a special camera for direct photography is to be purchased; the Eastman View Camera, No. 2-D, in the 5 x 7 size is recommended. This camera has detachable lens boards, and the several lenses to be used with the camera should each be mounted on its own lens board, so that no time or trouble will be required to change from one lens to another, as for example, from the micro-teleplat used for bullet work to the ordinary lens used for taking photographs of evidence guns, etc.

For ordinary work with this camera, a lens of about 7½-inch focal length is suitable, and a lens of this kind should be purchased, mounted in a suitable shutter. The micro-teleplat lens of 48 millimeters focal length, used for direct photography of bullets and cartridges is too small to fit into the usual shutter without an adapter, so that it is best to purchase a shutter, or a shutter with an adapter, for this lens from the maker of the lens.

In order to take good pictures conveniently with the view camera, it is necessary to have a good strong tripod, rigid and free from vibration, and readily adjustable as to height. The "Crown" tripod No. 2, costing $11.00 is very satisfactory. It is a great convenience to have a tilting top for the tripod, which is an extra attachment permitting the camera to be tilted to any angle desired up to the vertical. This device, costing $4.00, permits the photography of guns and other objects to be accomplished with great convenience by laying them on the floor and placing the camera in a vertical position over the top of them. For such photography it is best to have a plain background that is not too glaringly white; after using a white sheet or paper for some years, the author finally came to the use of ordinary brown wrapping paper as the kind of background giving the best contrast. In taking vertical pictures in this way, the author has adopted the trick of laying the revolver or other such object on a sheet of glass supported several inches above the background; thus no shadow is thrown, and the revolver appears clearly outlined on all sides.

A trick that is worth knowing is the use of a 45 degree prism for photographing the breech face of a side ejection revolver, where the camera cannot be placed directly in front of the surface itself. If the gun is placed with the barrel vertical, and the prism is laid in the breech recess with one of the right angled sides flat on the breech face, the surface will be clearly seen in the vertical side of the prism. This idea was shown to the author by Lieut. John H. Fowler, firearms expert of the Washington Police Force.

INSTRUMENTS NEEDED BY THE ADVANCED RESEARCH WORKER

These paragraphs do not by any means pretend to give a complete list of the materials needed by the research worker in this field. In the first place, such a worker will be the best judge of what he may need, and in the second place, his needs will change as new developments arise, and he will probably invent or adapt new instruments to the needs of the job as they occur to him.

The purpose of these paragraphs is to describe several instruments that are listed in the catalogs of bullet identification material, but which are, in the author's opinion, not very much needed by the average advanced firearms identification man. Firearms identification as it is practised today in America is a relatively new development, which has arisen almost entirely in the last dozen years, and there has been quite a change in the theory of what could or would be done by such a worker, and of what tools or instruments he would need.

One thing that was much talked of in the early literature was the question of telling from a found bullet what make and type of gun fired it. This would involve extremely accurate and complete data as to the standards of every maker, and in addition, extremely accurate and complete measurements of the found bullet, including such difficult things as determining accurately the pitch of the rifling, etc.

This theory is very attractive, but the actual hard facts of the practice of firearms identification place so many difficulties in the way, that most of our best men on this work have practically abandoned the idea of attempting anything more by this method than eliminating the most unlikely guns, and even this they usually do by comparing the evidence bullet under the microscope with known samples fired from guns of known make, of which every good identication man will collect as complete a series as possible.

For this reason, the instruments that are designed and sold for such purposes as making very accurate measurements of groove widths or of the twist of rifling in sample arms are used chiefly by the research worker or hobbyist, and are comparatively little needed or used by the routine worker. Among these instruments may be mentioned the following.

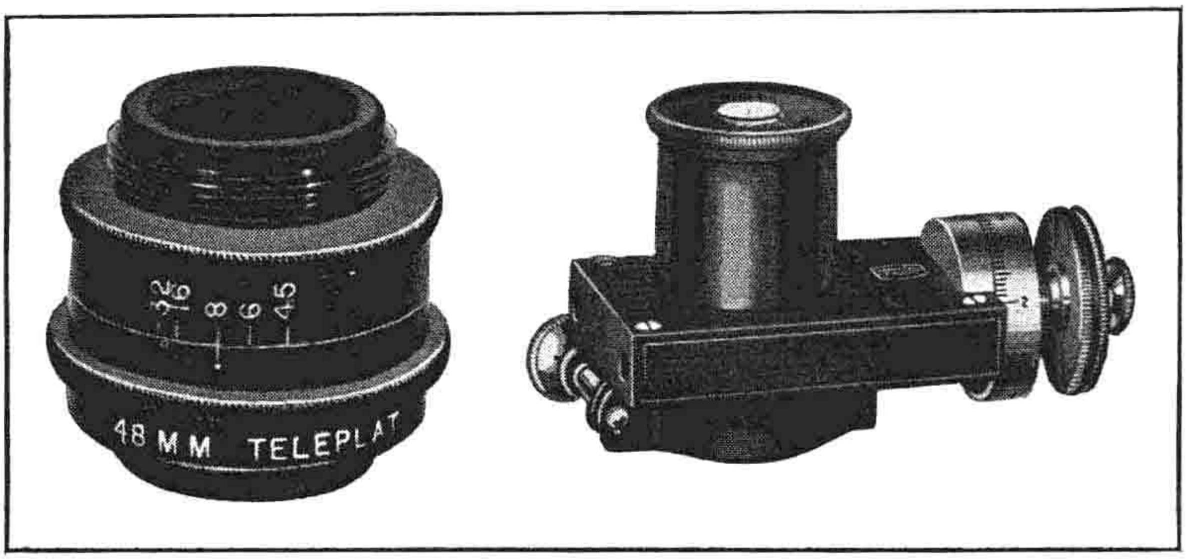
Filar Micrometer

An extremely useful device for making measurements of the greatest precision is the Filar Micrometer eye piece for the microscope. This is an eye piece fitted with a movable thread or cross hair in the field of view; hence the name from the Latin "filum" meaning a thread.

The cross hair is moved by means of a graduated knob on the outside of the eye piece. Each rotation of the drum moves the wire 1 mm. across the field of view and as the drum is divided into one hundred parts each division corresponds to a motion of .01 mm. or .00039 inch.

To measure an object with this micrometer, the object is placed in the field of view of the microscope and focused and then the amount that the cross hair must be moved to travel from one side of the image to the other is recorded. This is the actual size of the magnified image, and to get the actual size of the object itself this reading must be divided by the magnification.

For precision work it is necessary to measure some object of known length under the microscope and this shows you how much each division of the micrometer corresponds to for the magnification in question. It is usual to purchase with the Filar Micrometer a stage micrometer which is merely a little glass slip ruled with lines one thousandth of an inch apart or with lines .01 mm. apart. Before making the measurement with the Filar Micrometer the stage micrometer is laid on the stage or platform of the microscope and brought to focus, and then the number of divisions that the drum must be turned to move the wire across one of the known divisions on the stage micrometer is noted. Thus if for example it takes ten divisions of the drum to move the cross hair over one of the one thousandth inch divisions on the stage micrometer then each division on the drum will be .0001 of an inch in measuring objects at the same magnification.



Left: An excellent lens for making enlarged photographs of bullets, either with a microscope, or with a camera alone, the Micro-Teleplat lens made by Spencer. The 48 mm focal length is best adapted to bullet work.

Right: The Filar Micrometer Eyepiece for making fine measurements by the aid of the microscope. The graduated drum moves a fine index line across the field of view, and extremely precise measurements may be made by noting the motion required to carry the moving index line across the image of the object to be measured as it is viewed in the microscope.

The type of Filar Micrometer eyepiece made by Spencer Lens Co. does not have a cross-wire, but instead, has a finely ruled glass scale which is moved by the rotation of the micrometer head. Each division of the scale is equal to one revolution of the drum. The use of a ruled scale instead of a wire does not change the principle of the instrument, but is said to have the advantage that the index does not have to be traversed the entire distance of the object; the fraction of one division of the scale is all that must be read. In measuring the length of an object in the field of view, the scale is moved until one of the millimeter lines coincides with the margin of the object, then the total number of divisions of the glass scale lying on the object is noted, and the fractional part of the last division, determined by reading it to hundredths by means of the drum, is added.

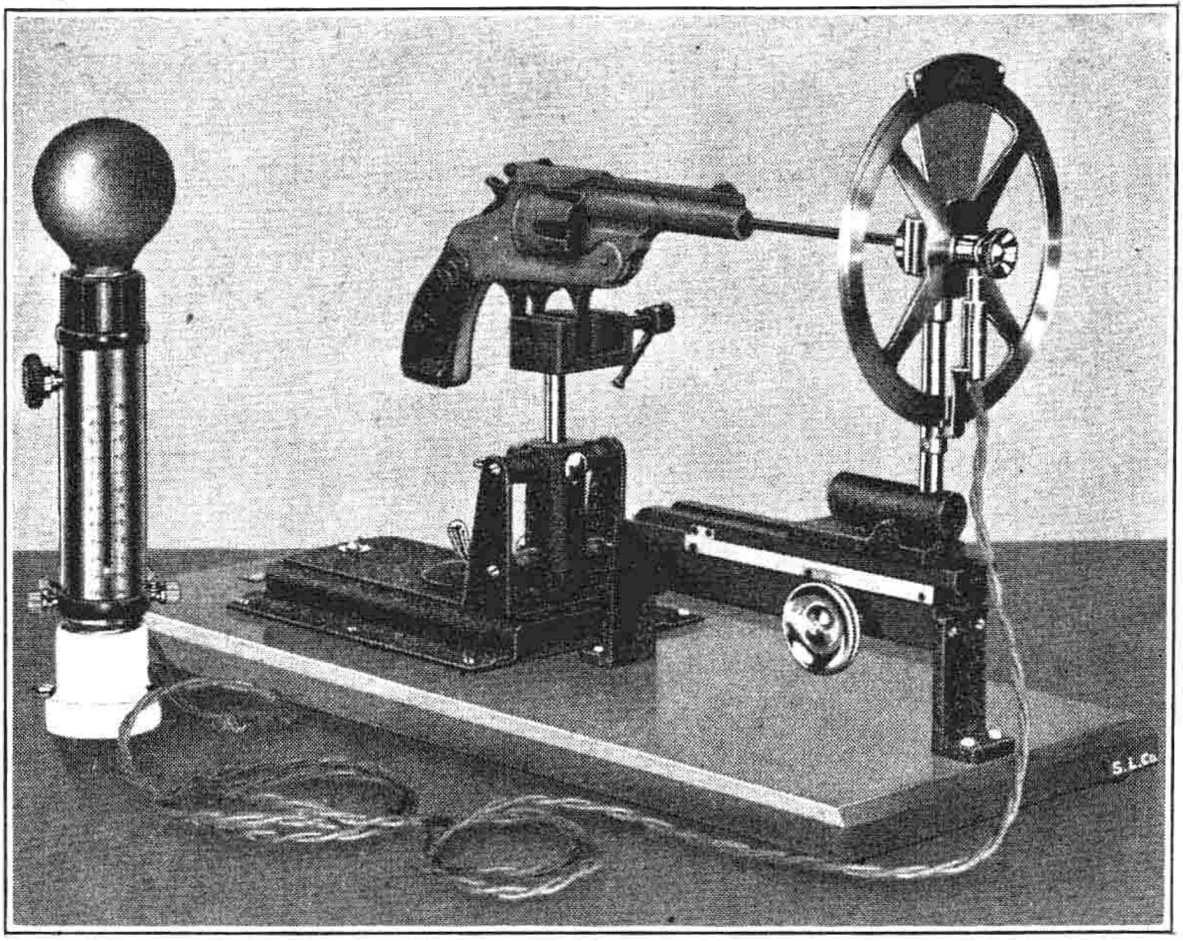
While the author would not recommend the purchase of this instrument to the routine worker, he owns one himself, and finds it extremely useful in such work as for example, collecting data for a book of this kind by measuring land and groove impressions on casts of sample guns of old or obsolete models, etc.; or of measuring a large number of guns of one make to determine how much variation may be expected. The worker who knows about such an instrument will, with experience, learn whether or not he will have use for it himself.

The intending purchaser of one of these instruments should realize that without the stage micrometer which goes with it as a standard, it cannot be correctly used, for with every change of objective or of tube length of the microscope, the meanings of the graduations will change, and they should be checked with the stage micrometer for the exact conditions of use. The Filar Eyepiece costs $45.00, and the stage micrometer to go with it costs $7.00.

The Goddard Helixometer

In the same class as to its necessity and desirability is the "helixometer" developed by Goddard and Fisher, which is described below. It is a fine thing to have in a complete laboratory, but like other fine laboratory apparatus, it is expensive; the list price is $175.

It is very useful to be able to examine the inside of the bores of firearms. The medical profession has long used instruments such as the cystoscope, naso-pharyngoscope and etc. These are nothing more or less than small magnifying periscopes carrying a small light on the far end and used for the purpose of viewing the interior of various body cavities. Such a small periscope can also be used for viewing the inside of the barrels of firearms. Such an instrument is often helpful in locating dust particles such as tobacco grains, etc. which accumulate in the gun barrel when the weapon is carried in the pocket. Thus the presence in a barrel of tobacco grains of a certain kind and of similar grains in the pocket of a suspect might help materially in directing the investigation into proper channels. However, the most important use of this instrument is for measuring with extreme accuracy the pitch of the rifling in a weapon. For this purpose the viewing telescope is mounted in a rotatable bearing and fitted with a graduated disc or protractor reading circular measurements to a precision of 3 minutes of arc. The frame carrying the periscope and its protractor is slideably mounted, and is arranged to be moved backward and forward by a rack and pinion carrying a scale by which the motion can be recorded. The field of view of the instrument carries cross hairs. Thus by fixing the cross hair on the edge of a groove, and reading the position from the scale on the base and the angle from the protractor, a starting point is obtained for measuring the pitch of the rifling. If the instrument is then advanced into the gun and the graduated circle is rotated at the same time, so as to keep the center of the cross hairs constantly on the same groove until a certain angle, say 45°, has been passed through, the pitch of the rifling in inches can be obtained at once by taking eight times the distance the instrument has been advanced into the gun barrel, since 45° is one-eighth of the complete circle.



Helixometer made by the Spencer Lens Co., (Goddard Type). This instrument consists of a small telescope mounted so that it can be used to examine the inside of a gun barrel. It carries its own light on the end, and is fitted with cross-wires. By following the edge of a land with the wires as the instrument is inserted in the gun barrel, and at the same time recording the amount that the instrument is turned for a given longitudinal motion, the pitch of the rifling may be obtained.

CHAPTER 7

PRELIMINARY FIREARMS INVESTIGATION

THE entire field of endeavor of the firearms experts in criminal cases naturally divides itself into two sections or phases of investigation.

The first phase, and perhaps the most important, is what may well be termed the "preliminary" or police phase. This is the advance investigation which should be made by any qualified police or detective force on the spot, assisted by such examination as may be possible of the actual weapon or bullet with which the crime was committed, or of the fired cartridge case, if one should be found at the scene of the crime, as is often the case when an automatic pistol is used.

Work of this kind does not require any expensive and complicated apparatus, nor does it require technical training or laboratory knowledge. What it does require is a general knowledge of all kinds of firearms, how they are made and operate, the kinds of cartridges used etc., coupled with good hard common sense and an observant disposition. There is any amount of accurate and practical evidence at hand in every shooting crime, if the investigators only have the necessary knowledge of firearms and the knack of observing pertinent points. Such evidence is often of the utmost value to the police in building up a case with the certainty that they are on the right track, and is of even more vital importance to the innocent victim of circumstances who will be cleared of suspicion if the real facts are known. And it takes no great amount of mysterious knowledge to be able to see much evidence of this kind that is often overlooked.

A man who takes an intelligent interest in firearms, and knows only as much about them as may be learned by belonging to a rifle or revolver club, joining in the matches, doing a little reloading, reading the literature on the subject of guns and pistols, and study-ing the catalogs of the various makers of arms and ammunition can often be of inestimable value to the cause of justice.

In another chapter, two such instances were quoted. In one case the police were holding a man for murder because he possessed a .38 caliber automatic pistol firing bullets of the same caliber and shape as the fatal one; but it took a local firearms enthusiast to point out that whereas the pistol in question had six rifling grooves, the fatal bullet showed seven, and therefore could not possibly have come from the same gun. In the other quoted case, the suspect had a .45 Colt Automatic pistol, and the victim was killed with a bullet of this caliber. But the firearms expert quietly upset the case by pointing out that the bullet showed *right handed rifling,* whereas the Colt guns all have the rifling turning to the left.

Both these cases were simplicity itself, but without the intervention of a man who has a thorough practical knowledge of firearms and an idea of what to look for, an innocent man might have been convicted of murder in each case.

Every police force should have, either on the force, or available to it, an individual who can be depended on for such work. It requires no expensive apparatus. All that is needed in the way of equipment for such work is a hand magnifying glass, a pair of micrometer calipers, and an accurate pair of scales for weighing bullets, together with what knowledge the expert has in his head or available in catalogs and handbooks, etc., but this is a tremendous lot if properly used.

With such an individual attached to any local police or detective force it is generally a simple matter to work out various leads to the solution of any shooting mystery and accurately *build up a case* against the proper person. What any police force really wants is the honest experience and evidence which will enable them to proceed with certainty against the *right person.* The police have no interest in "framing" a case against anyone, and with a qualified firearms expert at their disposal they can promptly get on the right track and "get their man." And right here is where Phase 1 of this work, or the duties of the Departmental Expert should, in general, stop. Once the case is built up against the guilty person and the case goes into court, Phase 2 starts, and it is time to call in the Professional Expert, the man with the scientific training, apparatus, and knowledge necessary to clinch the case and win the verdict—provided, of course, that such convincing testimony is necessary.

Let me give an actual incident showing just how this "practical" knowledge of firearms was of inestimable value in keeping the police on the right track, and clearing the air of confusion that the criminal was attempting to produce by perjured testimony. Some years ago the police of one of our large Eastern cities found it advisable to consult a local firearms expert in connection with the preliminary investigation of a homicide just committed. This was before the day of advanced bullet identification by means of the microscope.

About 8.00 a. m. of that day one of the local police officers had been shot twice and instantly killed by a negro who at the same time made his escape. There were no immediate witnesses to the shooting, but the police at once set their net and in about two hours brought in the man that they were convinced was the guilty person. When arrested, the negro still had on his person the .45 S. & W. Model 1917 revolver with which the shooting had been done, and its cylinder held four empty cases and two live cartridges.

But the accused stoutly insisted that he had last shot the revolver some four weeks previously, at which time he had fired all four shots at a mark in the woods, and he called on some three or four "cousins" to substantiate his statement. All these witnesses, with that suave perjury so often seen when one of the race is in danger, claimed to have been present on the occasion and to have seen all four shots fired at the mark in the woods. There was no shaking their testimony, either. Then the detectives thought of their firearms friend, and at noon, only some four hours after the crime was committed, they brought him into the case and asked him if it were possible to tell if the .45 caliber revolver in question had been fired recently. He gave hardly more than one glance at the weapon before stating that beyond question two of the chambers of the gun had been fired within the past six hours, whereas the other two had been fired at least some two or three weeks previously.

Now it did not take more than an elementary knowledge of firearms to perceive that fact, as the two cylinders that had just been fired showed this fact plainly by their fresh fouling and odor, and as the expert pointed out, they were "almost smoking;" whereas the other two cylinders, which had been fired off at a mark in the woods some weeks previously, were coated with corrosion "set-up," and streaks of red rust had commenced to appear as this was in the days of corrosive primers.

But the expert remembered a certain distinctive feature about the gun in question, and he said to the detectives, "I believe that I can go down into the cell room and pick out the man who did this killing without being told or shown who he is." This was gladly agreed to, and all hands proceeded to the cell room, where there were seven negroes in all locked up at that time. The expert said: "All of you face me and hold out your hands towards me so that I can see the palms of your hands." Then without a moment's hesitation, he pointed to one negro, and said, "There is the man who shot the policeman, and he did it with his left hand!" The negro in question who was indeed the suspect in the case said "My Gawd, boss, how did you know I killed him?" and promptly confessed.

The detectives were much elated, and moreover, they were astounded at the ability of the expert to pick out the guilty man. Of course, after all it was childishly simple when explained. As most experienced shooters know, the .45 Smith & Wesson revolver has a rather thin, narrow grip, with a straight nearly vertical part of the metal of the frame extending above the wooden handles at the back part of the grip near the top. This is rather hard on the hand of the shooter unless he is toughened to it and knows how to take care of the recoil. Almost invariably the straight part of the frame above the grip will bruise or split the "web" of one's shooting hand between the thumb and forefinger where that sharp vertical part of the grip bears. In this case, the expert simply looked at this point on the hands of every negro in the cell room, and then indicated as the murderer the only one whose hand showed these marks. And as it was the left hand that had been split between the thumb and forefinger when those two shots had been fired four hours previously, he also announced that the murderer was left handed.

"Elementary, my dear Watson, elementary!" And while it possibly was not evidence that could be used to advantage in court, nevertheless it broke down the prisoner's assurance, and was instrumental in securing a conviction.

Legal Procedure in Homicide Cases

The firearms investigator is not always connected with the police department or the district attorney's office; as we have seen above, he may very well be simply a local firearms expert who never has had any intention of becoming involved in court work with firearms, and who from one circumstance or another finds himself engaged in helping to clarify a shooting mystery. It is well for such a man to have a clear notion of the usual legal procedure connected with shooting cases; this may save him from making some embarrassing mistake.

The *Coroner* or *Medical Examiner* is the official whose duty it is to investigate all cases of violent death and determine the cause thereof. Until his decision is given, he has full charge of the body and all the evidence.

The usual procedure in any large city, where many homicide cases are handled every month, is about as follows. When a patrolman or other police officer discovers or is informed that someone has been shot, he notifies the District Headquarters immediately, and if not already there proceeds to the location of the body. If there still appears to be life, he summons a physician, or causes the victim to be removed to a hospital; but if the victim is already dead, he remains at the scene and prevents anyone from touching the body or any of the evidence or disturbing anything.

When headquarters receives word of a death by shooting, they at once notify the Coroner, and at the same time send out one or more detectives from the homicide squad, together with the fingerprint man and photographer. If these arrive before the coroner, they remain until he arrives without disturbing the evidence in any way. Legally, the entire investigation is under the sole jurisdiction of the coroner until his verdict is reached, and nothing can be done without his direction; but actually, the detectives, the finger print man and photographer usually work in close co-operation with the coroner, and by an understanding with him, they may proceed to start taking the necessary photographs, making records of any finger prints, etc., but the body must not be moved or any of the evidence removed or disturbed until the coroner so directs.

On the arrival of the coroner, he makes such an investigation of the circumstances as he may see fit, and if it seems to have clearly been an accident or suicide, he may so certify. But if it appears to him that it may be a homicide, he impanels a jury and holds a formal inquest; and he also orders the body removed to the morgue for an autopsy, which is made by a physician who is one of his assistants. The coroner's jury, on the completion of the inquest, render a verdict as to the cause of death. If the coroner's jury find that a murder has been committed, the case passes into the hands of the district attorney's office for the indictment, arrest, and trial of the individual or of the parties who are finally found to be responsible for the crime.

Evidence Obtained from Examination of the Wound

While this chapter deals primarily with evidence obtained by a consideration of the weapons involved in the shooting case it would not be complete unless mention was made of the very large amount of information that can sometimes be obtained from the wounds, burns, etc. on the body of the victim. The effects of projectiles and of the powder gases, etc., on the body involve many problems that may come before the firearms expert for solution or which may aid him in reaching a proper conclusion. In the succeeding pages, these topics will be discussed under the following headings:

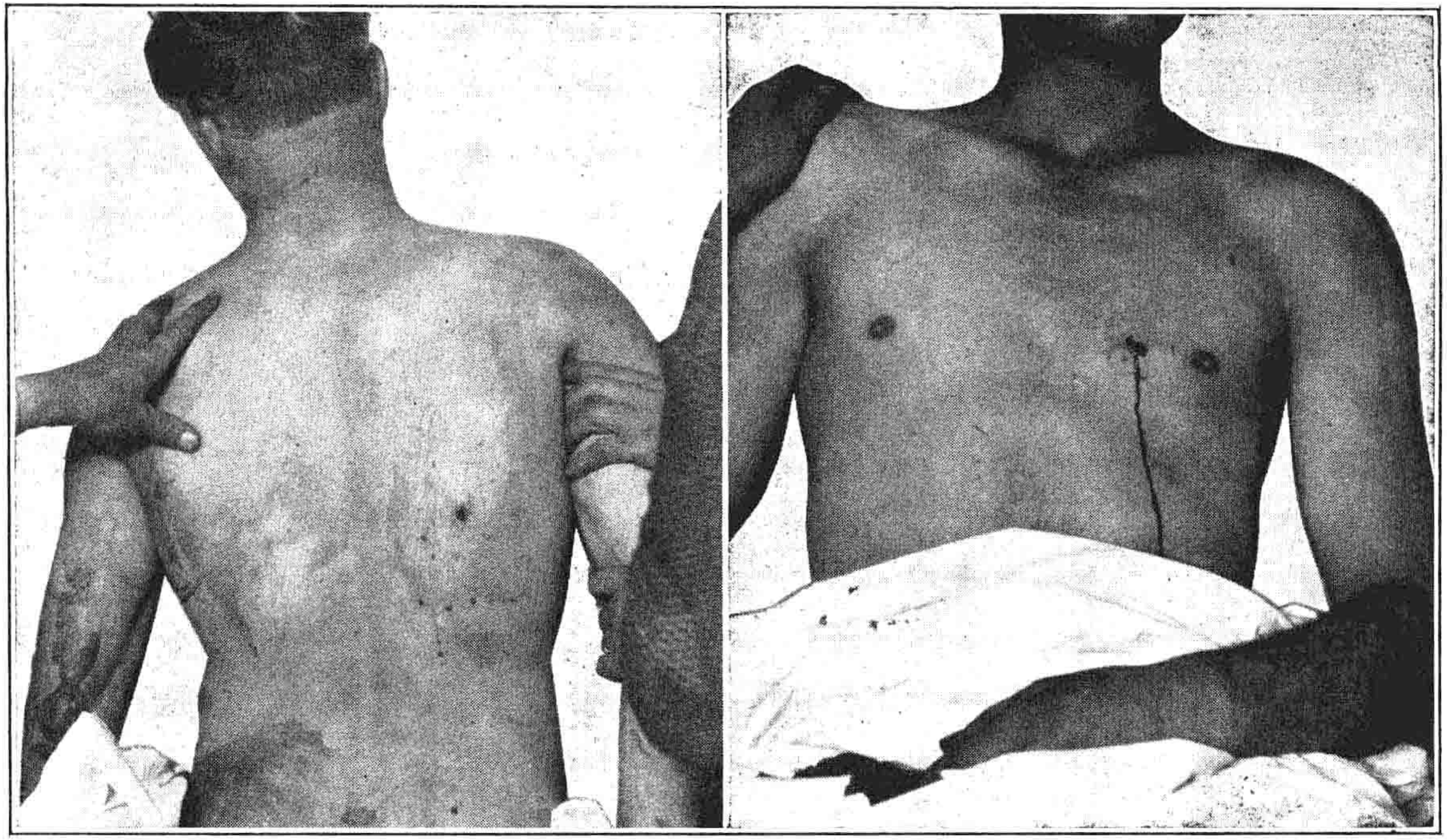
1. Distinguishing a gunshot wound from one not caused by firearms.
2. At what distance was the firearm discharged?
3. How was the wound inflicted?
4. Was it accident, suicide or homicide?

While it will be seen, from what has been said above, that this is primarily a question that is within the jurisdiction of the coroner, who is charged with determining the cause of death, there is nevertheless very often an opportunity for the firearms expert to be allowed to see what is being done, and to view the body, and very often some of the things that may thus come to his attention may be of material assistance to him in reaching a proper conclusion as to what has happened. Of course, the post mortem examination will definitely answer many questions; but this fact should in no way deter the firearms expert from observing all he possibly can, and attempting to fit the observed facts as to powder marks, size and character of the wound, etc., to his knowledge of the way in which the various firearms act so as to gain the clearest possible idea as to the facts in the case.

Accordingly the question of wounds and marks on the body will be discussed at some length below, with the caution to the reader that he should realize that this whole subject belongs more to the province of the coroner or the medical examiner than to the firearms expert.

Distinguishing a Gunshot Wound

Strangely enough it is not always easy at first glance to tell whether or not a wound was inflicted by a bullet, but a close examination will remove all doubt except when only a superficial



Right: Corpse of a man shot in the back with .38 Special revolver, showing wound of exit. Compare this with the wound of entrance shown in the other photograph. Note that the wound of entrance is round and there is very little bleeding, while the exit is oblong, as the bullet has tipped over during its passage through the body, and the bleeding here is profuse.

Left: Corpse of a man shot in the back with a .38 Special Revolver, showing the wound of entrance. **It is often of the utmost importance to be able to say with certainty which is the entrance, and which is the exit of the bullet, and this is particularly vital when the claim of self-defense is made, for if the wound of entrance is in the back, as in this case, the shooting was hardly done in self-defense.**

scratch or abrasion is found, such as is caused by a bullet which only grazes the victim.

Wounds of Entrance and Exit

All gunshot wounds have an entrance and all those which go clear through have a wound of exit. It is always highly important to know which is the entrance wound and which is the exit. This is especially important in cases where self defense is alleged. If the victim has a hole straight through the body a certain identification of the wound of entrance and of exit will show whether or not he was approaching or running away when shot. If, as is often the case, the victim was shot in the back, the allegation of self defense would fail. Two photographs with this chapter show the front and back views of the body of a man who was killed by being shot in the back with a .38 caliber S. & W. Special revolver. These photographs plainly show the difference between the entrance and exit wounds.

Wound of Entrance

The skin wound of entrance always corresponds in size to the diameter of the bullet used. It is very common for the aperture of entrance to appear smaller than the diameter of the bullet, but this is an illusion, since the wound invariably admits a projectile similar to the one which caused it. The small appearance is due to elasticity and shrinkage of the skin. Direct impact causes a round wound of entrance, while glancing shots, or those striking the skin at an angle, show oval openings. A wound of entrance in skin lying over loose tissue may appear much smaller than the projectile, on account of the extreme elasticity of the skin in certain regions of the body. Bullets from high powered rifles may show only a mere slit in skin which is wrinkled like that of the neck, elbow or knee, etc. On the other hand, wounds in skin overlying bones or other highly resistant tissues may show openings exceeding the size of the bullet.

The edges of the wound may be scorched or not, depending on the proximity of the muzzle at the time of discharge and on the kind of powder used. Black powder, which ejects a considerable proportion of solid material with the gases, causes burning and tatooing with close shots. On the other hand, smokeless powder causes little or no burning, and the tatooing is less marked. Sometimes lubricated lead bullets will leave a dark coating in the edges of the skin around the entrance wound, and on careless examination this may be mistaken for burning.

Bleeding is usually slight from the wound of entrance and much more pronounced from the wound of exit. When the muzzle of the gun is held in contact with the skin, the surface may be torn and lacerated, and powder marks on the surface may be entirely absent, on account of the powder grains ejected from the muzzle having all gone inside. In such wounds, the gas from the muzzle, entering the wound, will often separate the tissues over a large area, and make terrible injuries.

Wound of Exit

The wound of exit is usually larger than the wound of entrance, and in case a bone is struck it may exceed the size of the projectile very greatly. In general, it is more irregular than the wound of entrance, and frequently it shows the print of a bullet which has passed out sideways, having been turned over during its passage through the body, especially if a bone has been struck.

The exit wound never exhibits tatooing, burning or other such disfigurement, nor does it show pieces of cloth from the clothing driven into the wound, as is often the case with the wound of entrance. The edges of the wound are usually pushed outward, and fat or tissue may protrude from it. Bleeding is much more marked at the wound of exit.

When a bone has been struck there may be several exit wounds, as pieces of bone may be put into motion by the bullet so as to form missiles which pierce the skin. These "secondary missiles" often enormously increase the damage done by a bullet, and especially with a high powered bullet which strikes bony structure, the dozens of pieces of bone driven in every direction like small bullets in themselves, may be responsible for a large proportion of the injury. Occasionally, they may even cause a major injury to a person not struck by the original shot. A case occurred in the Army where a man was found in a tent apparently shot through the eye. He was taken to the hospital, and the wound washed out, but no bullet could be found, though a large chunk of bone, that did not seem to be very well accounted for was loose in the wound. After the wound was dressed, someone discovered another man lying dead in the same tent, and it developed that the first man had not been shot at all, but instead, had been struck by a flying piece of bone dislodged by the bullet which struck the other man.

Sometimes, especially in the case of pistol bullets, the bullet may follow the contour of a rib or of the skull without penetrating the bone. I have known of a man shot in the chest at close range with a .38 Long Colt revolver who fell down and expected to die, and all of his friends expected him to die. He had a well defined wound of entrance in the left side of the chest but he recovered promptly because the bullet had struck a rib and gone around to his back just under the skin without going into the pleural cavity at all. Again, it is rather common for a bullet striking on the skull with a glancing blow to travel around to the back of the head under the skin.

At What Distance Was the Shot Fired?

This is a most important question, and the answer is not always clear. The appearance of powder grains on the skin and the way in which they may have penetrated certain thicknesses of clothing, will often give an approximate answer to this question.

This question of testifying as to the distance from which the shot was fired by noting the powder burns and the amount of unburned powder deposited on the surface is one where a little knowledge is truly a dangerous thing; the author has known of self styled experts who have gone on the stand and complacently testified as to how far away the gun would have to be from the victim to make such and such a character of mark without ever knowing or stating just what kind of powder was used, and without even knowing that different kinds of smokeless powder will vary widely in the distance to which they will project unburned powder grains even in the same cartridge.

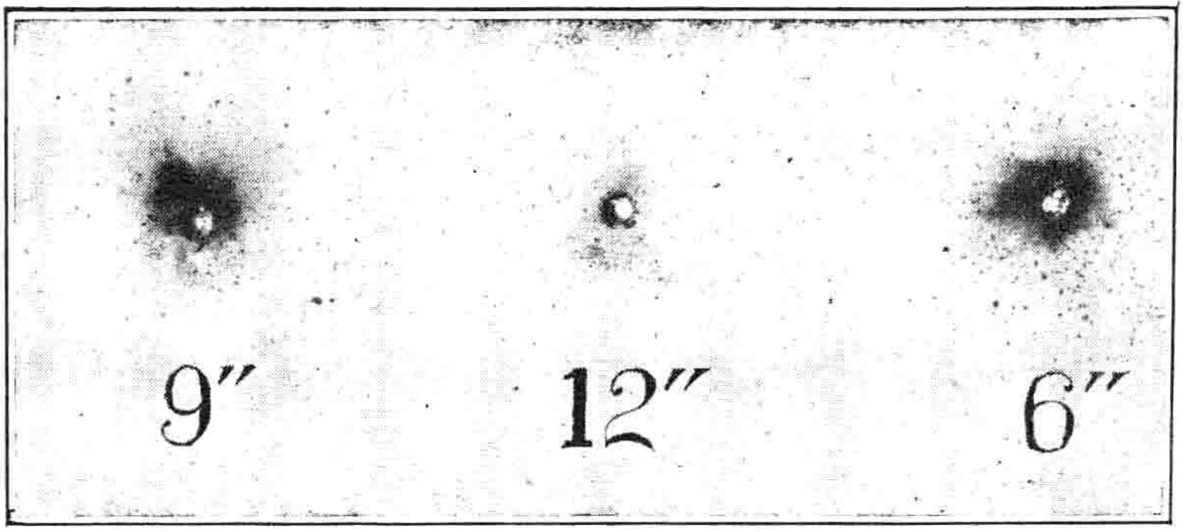
Black powder may project unburned grains as far as six feet and leave marks in the skin at this distance; while an automatic pistol loaded with smokeless powder may leave not the slightest trace of either scorching or powder marking at a distance of two inches. The author made tests at one time with a .380 Remington automatic, using two different kinds of cartridges, both loaded with smokeless powder, one of which left a heavy deposit of half burned grains at ten inches, while the other left not the slightest evidence of any powder grains or scorching on blotting paper at 2 inches. This and other similar experiences show that any testimony as to the distance at which scorching will occur is valueless unless the witness knows a great deal about this particular phase of firearms action, and moreover, knows what kind of powder was used, and what its pecularities are in this regard. In the absence of definite knowledge as to what kind of powder was used, about the only thing that can be said is that with pistols or revolvers with smokeless powder, the gun was certainly held within about a foot and a half if there are powder grains embedded in the skin. With black powder, the distance is greater. Moreover, when a weapon using black powder is held close to the clothing and discharged, the cloth is often set on fire. The author only recently walked into a room a few seconds after hearing the report of a revolver, and found a young man lying on the floor with a bullet wound in his chest and his shirt burning in a circle about three inches in diameter around the wound. There was no flame, but the shirt was actually on fire and glowing at several points around the charred circle. Needless to say, black powder was used, and the muzzle of the revolver was held close to the surface of the clothing. This was a case of attempted suicide, and although the bullet passed very close to the heart, the victim was sufficiently recovered to leave the hospital in ten days.

With shotguns, when the gun is fired very close to the body of the victim, the charge of shot all goes out in a mass, and makes a terrible hole; while if the gun is a few yards away, the shot begin to scatter. For this reason, it is quite possible to judge that the gun was or was not close to the victim when fired; but any attempt to reduce this distance to a matter of inches would appear to be sheer nonsense.

This matter of the spread of the shot will be affected by the size of the shot, the character of the wads used between powder and shot, the charge of powder, and the character of the boring of the gun; that is, whether choke or cylinder bore. Moreover, it may be very much affected by the character of the load; some loads are specially arranged with the shot in thin layers between cardboard wads, or with a cross division of cardboard in the shot charge, to cause the load to spread faster. These are known as "Brush" loads, and will show a much greater spread at any reasonable distance from the muzzle. But neither the choke or cylinder boring or the brush load will have any noticeable effect within a few inches of the muzzle, because the shot will not have had time to spread much, and any additional spread that does occur will be so small in amount that other irregularities will mask it entirely and make it impossible to determine the difference. Moreover, the size of the hole will be greatly affected by question of whether or not the shot strikes the surface at a right angle or on a slant. This question has been discussed at greater length elsewhere in the chapter.

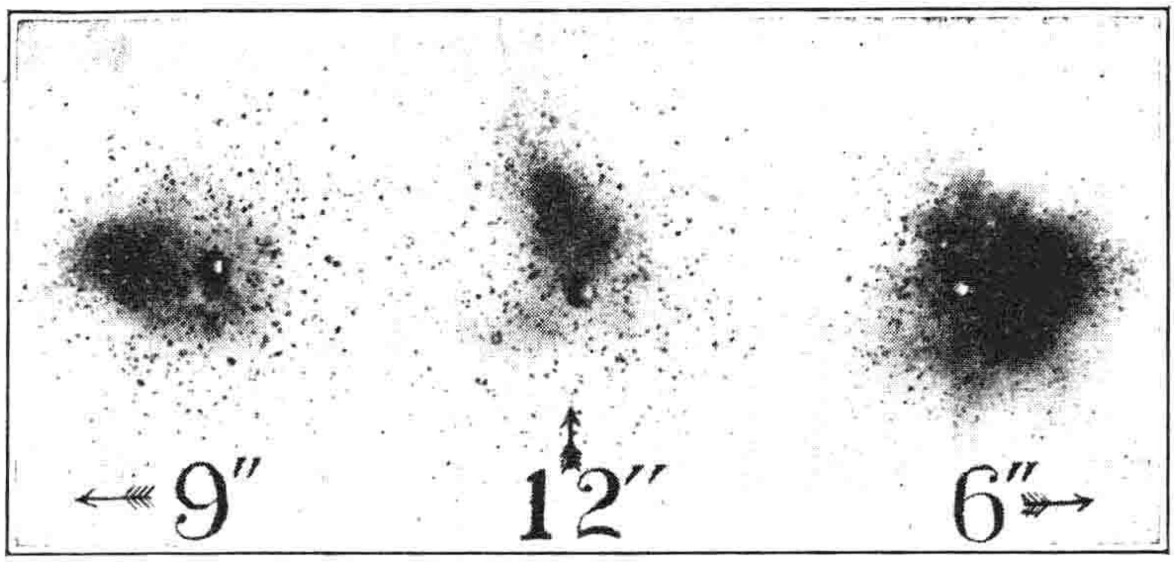
All these factors should prevent the aspiring firearms expert from rushing in "where angels fear to tread," and testifying positively that such and such a gunshot wound was made with the gun at exactly eight inches, or making some other such rash statement, which has all too often occurred in the past.

It is quite illuminating to make a series of firings with different lengths of barrel, different charges, and different kinds of powder, against a suitable target, to see just what the difference is. A material commonly used for this purpose is white blotting paper, and this does extremely well for comparative purposes; but here also a warning may be sounded. In one case the expert testified that his tests against blotting paper showed that the shot had been fired within a foot; but the defense successfully upset his testimony and secured an acquittal by the contention that the powder grains would show up better on the white blotting paper than they would on the swarthy skin of the deceased victim.



Powder marks left by a smokeless powder revolver cartridge. This series of tests is exactly similar to the one illustrated on the opposite page, except that the powerful .38/44 S.&W. Special cartridge loaded with smokeless powder was used, and the revolver was held in the normal upright position for all shots. Note that powder burning is practically absent at the 12 inch distance, in spite of the fact that the cartridge used was one of the most powerful modern smokeless revolver loads. It was seen that with black powder, the position of the "powder brand" in relation to the shot hole will invariably give an indication as to the position occupied by the top of the barrel; with smokeless powder this is not so, as the powder smudge is usually distributed more or less uniformly around the hole.

Burning of the clothing, scorching of the skin, or singeing of the hair will occur when a shot is fired at close range using black powder. At the same time the powder marks on the skin often indicate the manner in which the weapon was held when fired. Each weapon with a definite barrel length and charge of powder has a distance limit where deposits of partly burned powder grains will make an impression on the skin. It has been found, although this rarely occurs except with black powder, that in examining the marks of smoke and of burned and unburned grains of powder distributed around the bullet hole in the case of very close shots, one spot will be seen which is blacker and more burned than the rest. This is caused by the flame of the gases and the residue of the burned powder striking more strongly on this side of the bullet hole than anywhere else. It has been found that this "powder brand" near the bullet hole always occurs on the side of the weapon where the sights are located. This is caused by the fact that when the pistol or revolver is held in the hand, the main mass of the gun with its center of gravity lies below the line of the bore; and when the gun recoils it turns or jumps so as to throw the barrel upward or toward the hammer side of the weapon. Thus the gas following the bullet out will be deflected in the direction toward which the weapon moves when it jumps.



When a black powder cartridge is fired in a revolver at close range, there often remains an exceptionally heavy deposit of residue, or "powder brand," on the victim's skin or clothing, and this may give definnite evidence as to the position in which the arm was held when it was discharged. The illustration shows the powder brand which resulted from firing .38 S. & W. Special black powder cartridges at distances of 6 inches, 9 inches, and 12 inches from a target of white cardboard. In each case the top of the barrel of the revolver was turned toward a different direction, as indicated by the arrows. Thus, with the 9 inch shot, the gun was held on its side, with the barrel to the left; with the 12 inch shot, the gun was held in the usual manner, with the barrel upwards; while with the 6 inch shot, the gun was held on its side with the barrel to the right. In each case, the bulk of the deposit is on one side of the bullet hole, and in the direction occupied by the top of the barrel.

With the information gained in this way as to just how the weapon was held when it was discharged, it is frequently possible to differentiate between suicide and homicide.

However, in this connection a point which should not be overlooked is the fact that in cases of suicide the weapon is sometimes pressed and held so tightly against the surface by the suicide that the gasses and unconsumed powder grains are driven into the wound itself, leaving no marks on the skin surrounding it.

A lead bullet having the maximum velocity and striking bone may at times fail to penetrate as far as it does when having a somewhat lower velocity. For instance Colonel La Garde reports in his book on *Gunshot Wounds* that experimenters often notice, for instance, that a revolver bullet will perforate the skull of a cadaver at 25 feet and may fail to do so at contact or a foot or two away. The explanation given by him is this—that a lead bullet travelling at maximum velocity makes such a sudden and violent impact that the bone particles have not time to separate or give way to enable the ball to pass. The momentary resistance is such that the bullet flattens, hence the deformation which adds to the sectional area of the bullet, and to this deformation we ascribe the loss in penetration.

The author is inclined to doubt that this is the correct explanation of the failure of a bullet to penetrate as well at two feet as at twenty-five, for the difference in velocity is very small indeed and moreover other experiments have indicated that the greater velocity the greater the penetration. Most likely the failure of the close shot to penetrate is due to the fact that it has not yet become stabilized and therefore it more easily turns over on striking a resistance thus presenting its broad side with increased resistance to penetration.

This point came up some years ago in the case of a young officer of one of the Government services, an acquaintance of the present writer, when the Government sought to show that the officer came to his death by suicide by shooting when he lay on the ground in a struggle with other officers, who were endeavoring to restrain him. The muzzle of a .38 caliber Long Colt service revolver was held against the right side of the head and fired. The ball entered the skull and was lodged in the brain on the opposite side of the head more or less deformed. The prosecution maintained that the pistol discharged at such close range should have sent the ball through the head, and that in all probability the pistol was discharged at some distance by someone else. However, there were eye witnesses to this occurrence and other evidence to confirm the charge of suicide. The experts consulted in the case held to the opinion that the failure of the ball to penetrate completely at such a close range was due to loss of penetrating power by deformation of the bullet on impact. It was in this same shooting incident that the other officer was shot in the chest by a bullet which followed the rib without doing serious damage as was described above. This case is well remembered because it occurred in a town where the writer was living at the time and he happened to be acquainted with the principals in the affair.

How Was the Wound Inflicted?

It is often of the utmost importance to be able to tell whether the victim was facing the assailant or had his back to him when shot; also whether he was advancing, or running away. Usually in the absence of witnesses, the investigator will have to depend on the position of the wounds of entrance and exit to determine these points. Frequently, also, the relative position of these wounds will indicate the direction from which the shot came, and whether it was fired from a point higher than the entrance wound, on a level with it, or below it, etc.

In making any such deductions the investigator should be careful to ascertain if the track of the bullet in the tissues is a straight line, or whether it is curved, as it often is when the bullet becomes deflected by striking a bone.

Was It Accident, Suicide or Homicide?

While these questions are often impossible of a positive answer, yet in the majority of cases, there are circumstances or indications pointing to one conclusion or the other, or perhaps merely ruling out one of several suppositions, and thereby making it easier to determine the truth of the remaining ones.

For example, a man shot in the back at close range can hardly be called a suicide, and in this case, homicide would at once be assumed. Moreover, an attempt at suicide always shows a shot directed at a vital part of the body, and usually at the head.

In suicide, the victim usually tries to put a bullet into the brain, and the two favorite locations in which people shoot themselves are the inside of the mouth, (perhaps 62 per cent of all cases), and the temple, (perhaps 18 per cent of all cases). Relatively few people shoot themselves in the chest or abdomen. A notable exception is the would be near-suicide, who is a neurotic individual, usually love sick and always mentally weak, who dramatizes himself sufficiently to seek sympathy by pretending to attempt suicide. Usually he shoots himself through the shoulder or some other part of the chest, but he always manages to miss the heart, and usually recovers, though sometimes from one cause or another, usually infection of the wound, he really does die. Very frequently the actual wound and his danger brings him to his senses sufficiently to cause him to disclaim any intention of shooting himself, and try to make the shooting appear as an accident. In one case the victim clearly had been alone at the time of the shooting, which occurred just after an excited scene in which jealousy was a factor. He was shot in the upper part of the chest, and asserted that he had accidentally shot himself while taking an automatic pistol out of the bureau drawer to put under his pillow. He was horribly frightened, and begged the doctor to save his life, which was done with no great difficulty. Of course it cannot be said that the accident did not happen as he claimed; but I should like to be shown how a man could hold an automatic pistol so as to shoot himself in the chest. Try it yourself sometime, with an empty gun. Be sure it is empty, but if you do not deliberately pull the trigger how can it happen?

Suicide shots are usually delivered at close range, and as a consequence the skin usually shows powder marks, which should be carefully studied to determine the way in which the weapon was held. We have already described the "powder brand" which is found toward the hammer side of the weapon. This is of the greatest value in the case of supposed suicide, for if the investigator will take an unloaded revolver or pistol in his hand and go through the motions which a suicide must have followed to shoot himself in the location where the wound was found he will at once learn that the amount of latitude that one has in turning the weapon to the right or left is strictly limited. If the powder brand shows that the weapon was turned more than this motion would allow it would favor the theory of murder rather than suicide.

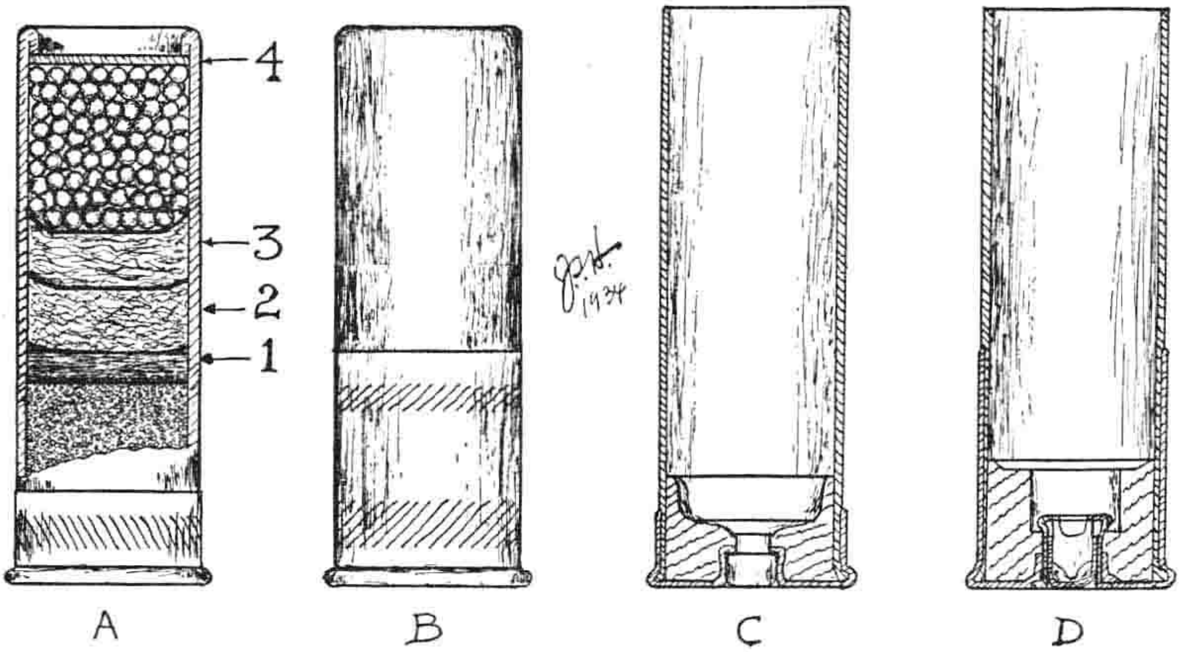
INVESTIGATION OF HOMICIDES OR ACCIDENTS WITH SHOTGUNS

If the larger towns and cities are left out of consideration, it will be found that the shotgun by far outnumbers all other kinds of weapons in common use or possession in this country. Practically every farmhouse in this broad land has a shotgun standing ready for use behind the door or in some convenient corner. This fact goes a long way in explaining the peace and security in which our more isolated farmers live; but at the same time it also accounts for the undoubted fact that the shotgun is responsible for more homicides and accidental shootings than any other weapon except the pistol or revolver.

Because the shotgun is intended to scatter a load of light shot, which will not kill even small feathered game at distances greater than about 80 yards, few people realize the extreme deadliness of this type of weapon at very short ranges, such as ten feet or under. It is doubtful if there exists today upon this earth an animal which cannot be killed, or at least instantly disabled with the 12 bore shotgun and a load of ordinary No. 4 shot, *provided* that the shooter wait until that animal comes up to the very muzzle of his gun before shooting. The result is that a veritable "rat hole" will be blown into the animal, and the tissues in and around the wound will be pulped and torn horribly by the load of shot entering the flesh in a churning mass. Nothing could be more effective in stopping the charge of an infuriated bull, just to quote one example.

A large percentage of the killings charged to shotguns are not intentional homicides, but are accidents resulting from some carelessness or mishap which occurs while the victim is hunting. Quite often there may be a question as to whether the victim shot himself, or was killed by another hunter, and it is not at all uncommon for the unfortunate hunting companion of a careless sportsman to find himself unjustly accused of having in one manner or another caused the fatality. On the other hand, cases have been known where the hunter who carelessly shot his companion has taken elaborate steps after the accident to make it appear that the deceased shot himself, even going so far as to take the fired cartridge case from his own gun and place it in that of the victim. At times, such questions as those mentioned above can be settled with assurance only by obtaining the services of a qualified firearms expert.

Perhaps the larger part of these hunting accidents are caused by ignorance on the part of the victim or his companion, of even the most elementary safety precautions, or by the poor design or construction of the shotgun used, or by a combination of these two deadly causes. The average cheap shotgun is a most ill constructed affair, with the mechanism crudely fitted, and under many conditions may be inherently dangerous. For example, the usual single barrel shotgun is made with the old type exposed hammer; that is, it is a "hammer" gun; and most people firmly believe that when the hammer of such gun is in the "down" position, (not cocked for firing), the gun is safe. Nothing could be further from the truth; the weapon is, in fact, more dangerous than when the hammer is cocked, just because of this mental attitude on the part of the user, coupled with several deadly mechanical chances for accidental discharge. The gun can readily be fired by permitting the hammer to be drawn part way back and then be released, when it will fall and explode the primer. This is exactly what happens in many accidents with shotguns; the lowered hammer catches on



SHOTGUN SHELL CONSTRUCTION.

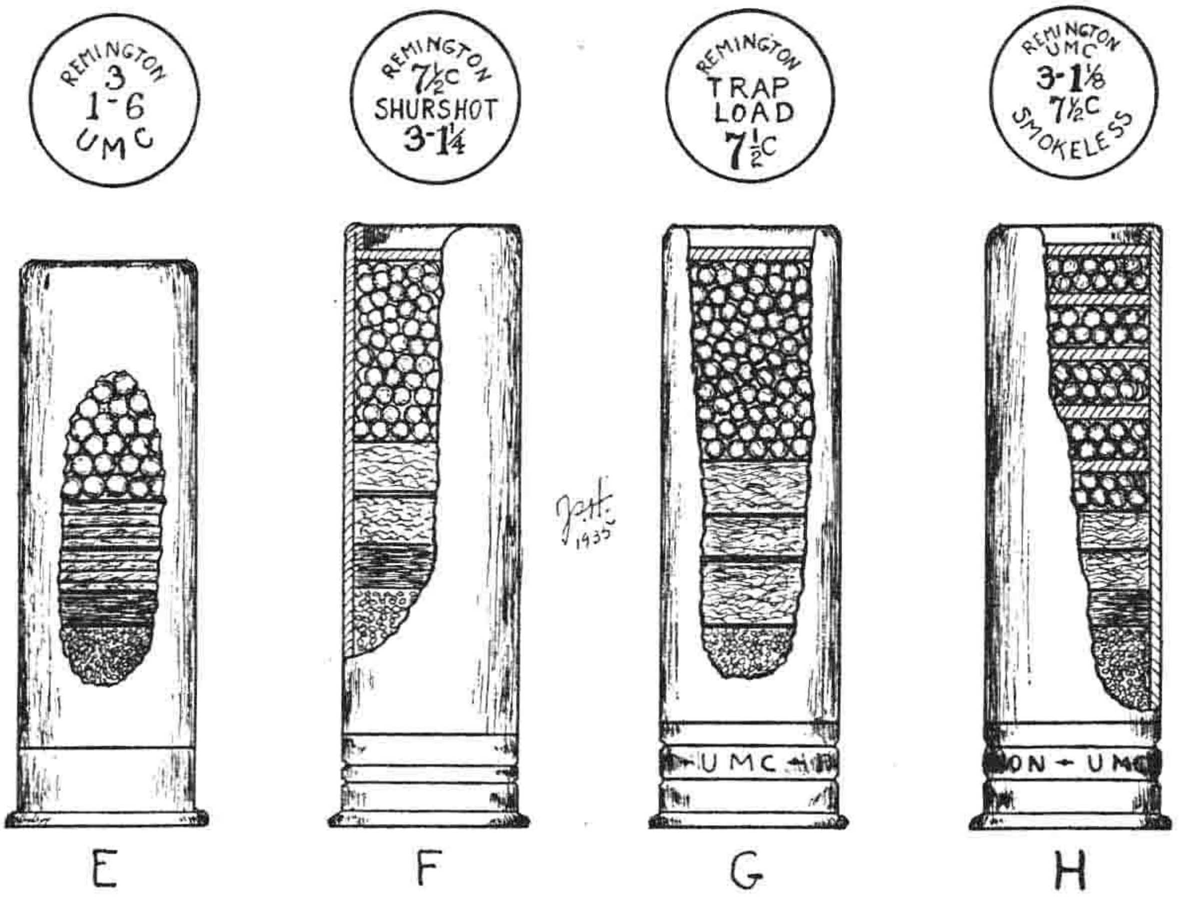
A Typical arrangement of a loaded shotgun shell. First comes the powder charge, on top of which there is a wad, No. 1, usually of cardboard about 1/8 inch thick, though at times a dry and greaseless felt wad of the same thickness is used instead of cardboard. Sometimes the cardboard wad is what is known as a "greaseproof" wad, which is covered on both sides with black waterproof paper, or is made throughout of this black paper. The purpose of this wad is to prevent the blast of certain types of powder from blowing the felt wads to pieces, as well as to prevent the seepage of oil from the felt into the powder charge. Next come wads 2 and 3, which are usually felt wads, either 3/16, 1/4, or 3/8 of an inch thick, but may be of compressed ground cork mixture or of some other special composition. Various different kinds and trade names of felt wads may be used, such as "Black Edge," "White Felt," "Nitro Felt," etc., and various thicknesses and combinations are used, according to the type of load and the manufacturer's ideas. It is sometimes considered a ballistic advantage for the felt wads to be cupped as shown. This may be done by the rammer used in loading the shell, or in the case of composition wads, they may be moulded in a concave shape. Next comes the load of shot, which is held in place by a thin cardboard wad, No. 4, which usually has the size of the shot, and various other information, according to the fancy of the maker, stamped or printed on it. Sketch "A" also shows what is known as a "Low Brass" shell, in which the brass head extends only a short way up the side.

B "High Brass" shell, in which the brass extends further up the side.

C "Low Base" shell, in which the paper reinforcement inside the head of the shell is relatively small in amount. This is the usual construction when black or "bulk" smokeless powders are used. The primer shown is the old black powder type, resembling the ordinary rifle or pistol primer in size and construction.

D "High Base" shell, in which the paper reinforcement inside the head of the shell extends higher into the powder space, which is thus reduced in volume so as to make it suitable for use with concentrated or "Dense" smokeless powders, which require less space than do the ordinary black powder or the "Bulk" smokeless. This also shows the usual "Battery Cup" type of shotgun primer, commonly used in all but black powder shells.

a twig, the side of a boat or automobile, or in the clothing, pulls partly back, and then slips loose and falls, under the impulse of the mainspring. Then again, it is possible to fire the gun merely by striking the lowered hammer a heavy blow, such as may be the



VARIATIONS IN ARRANGEMENT OF WADS IN SHOT SHELLS

Diagrammatic sketch of four shells of the same make. These sketches were made from actual samples, and a careful attempt was made to have the thickness and location of all wads, etc., in exact proportion. Above each shell is a sketch of the top-shot wad, showing the lettering. It will be seen that there is a wide variation in both the kind of wads and their location, as well as in the kind and type of information given on the printed top shot wad, and as these samples are all of the same make, it will be seen that with all the different makes in existence, the number of different combinations is enormous.

E A black powder load, the "New Club," which has one cardboard wad over the powder, and two laminated felt wads on top of that.

F Remington "Shurshot".

G Nitro Club "Trap Load." Note that there is no card wad over the powder.

H Nitro Club "Scatter Load", with card wads between the layers of shot to cause the charge to scatter quickly for brush shooting, where the range is likely to be short.

result of dropping the gun so that it falls on the hammer. Or with cold and numbed hands, the user may draw the hammer back almost to full-cock and then let go, with a resulting accidental discharge. Any such old-fashioned gun is dangerous whether the hammers are up or down, and extreme precautions should be used in handling or using these weapons.

The modern "hammerless" shotgun is far safer in all respects than the old guns just referred to, but it has, in some cases, a serious fault of construction in that the "safety," or lock, located on top of the grip, *does not actually lock the weapon against discharge, but merely blocks the triggers from being pulled.* Hence, even though the gun may be properly locked and supposedly safe from accidental discharge, it is entirely possible for a hammer to become disengaged from the sear and fall, thus discharging the piece. This may be caused by any sharp blow or jar, such as would be caused by dropping the gun, or falling with it in one's hands; in fact, any severe and sudden jolt may jar the sear out of engagement with one or the other of the hammers. Oh, yes! A hammerless gun does have hammers, all right; only they are tucked in out of sight and covered up so that they cannot be seen, and what is more important, where they cannot catch on objects that may come in contact with the breech of the gun. While this does remove one major source of accident, it does not always make the gun entirely safe in the face of rough treatment, as has just been explained. Some of the cheaper hammerless double guns are notoriously poor in inner lock construction, and are most unsafe contraptions at any time.

Another standard source of accident is to have the firing pins or plungers on a shotgun become so rusted through neglect that they stick in the forward position in the gun breech after being struck by the hammers, and fail to retract themselves into the action and out of the way, as they are intended to do. Thus the point of the striker protrudes through the face of the breech, and if the action is snapped shut or closed smartly in reloading, the protruding point may strike the primer with sufficient force to cause a discharge. A few more ways of having a first class hunting accident are: having a dog or companion stumble over a gun stood up against a tree a few feet away, locked, of course, but loaded; groping about in the underbrush for a dead bird while trailing the loaded and unlocked gun at one's side until the trigger catches on a twig, (which is very likely to result in a bad mess such as taking the top of one's head off along with the hat); working the shells from the magazine of a pump or auto-loading gun and snapping the hammer on the last shell, which is in the chamber; standing with the butt of a loaded gun on the ground while an excited dog frolics and jumps about; standing the gun on one side of the fence, climbing over, and then dragging the gun through or over by the muzzle; holding the gun by the muzzle so as to avoid getting snow or dirt into it, and using the butt to poke a rabbit out of a pile of brush; and countless other happenings of the same kind. All these well known mistakes, together with any number of other unforeseen combinations of circumstances are what help to swell the large total of accidental shotgun deaths that occur in this country with amazing regularity. It all comes back to the human equation. The user of a gun may do strange and unaccountable things when under the excitement of the chase, but the gun will never do anything except what it was manufactured and intended for; which is to kill or maim whatever living thing happens to be in front of the muzzle when it is discharged.

The most popular gun today is the 12 gauge, and with ordinary bird or duck shot, the extreme killing range is little over 50 yards. There is some difference in killing range in favor of the larger bores. It is true that the 20 gauge, for example, will throw its pellets just as fast and as far as will a 12 gauge, and the individual pellets will have the same killing power; but the total effect of the charge in the smaller gauges is less, because of several factors. For one thing, there is a larger proportion of the charge in contact with the walls of the gun bore, so that more of the pellets are deformed, and tend to drop behind or be thrown off to one side. Several other factors enter here, and all arguments to the contrary notwithstanding, the practical and effective killing range of any shotgun is somewhat proportional to its gauge or bore, and a 12 gauge is a longer range and more consistent killer than a 20 gauge.

There is, of course, some difference in the killing range of any gauge, depending on the size of the shot used. Naturally, the larger sizes hold up in velocity better than the smaller ones, have greater energy at the longer ranges and therefore kill at greater distances.

Among other matters, the question of the extreme range of fired shot may come up. The shotgun is a fearfully effective weapon at extremely short ranges, as already stated, but its deadliness and efficiency rapidly fall off as the range increases. Comparatively speaking, it is only a close range weapon. However, individual pellets of shot may travel considerable distances, and the following tabulation gives the maximum ranges of the various sizes of shot when the gun is fired with the barrel nearly horizontal or but slightly elevated.

Shot Size	*Diameter in inches*	*Maximum range*
No. 2	.15	330 yards
No. 4	.13	286 yards
No. 6	.11	242 yards
No. 7½	.09½	209 yards
No. 8	.09	198 yards
No. 10	.07	154 yards

The method used in computing this maximum range is known as Journeé's formula, and consists in taking the maximum range in yards for any size of shot as roughly 2200 times the diameter of the shot pellets in inches. This formula should not be used as a guarantee of safety beyond these ranges, however, for it is possible for a larger shot to become mixed in with the regular charge, or for two shot to become balled or frozen together, and in such cases, the range will be somewhat greater.

This formula is for the case where the gun is fired nearly horizontally, as was stated above. This is the important case as far as injuries are concerned, for while the shot will carry to greater extreme ranges if the muzzle of the gun is elevated to a considerable angle, at the same time the resistance of the air will reduce the velocity of the descending shot to such a low figure that bodily injury from them is most unlikely. Nearly every sportsman has been spattered with returning pellets of shot fired at a high angle by some fellow sportsman, and can testify from experience that they strike with no more force than heavy raindrops.

Factors Which May be Investigated or Identified

Obviously the shotgun does not ordinarily leave regular markings on the missiles that can be compared under the microscope with test projectiles, as is the standard procedure with rifled arms. Some attempt has been made, especially abroad, to theorize on the possibility of comparing markings made on any of the recovered pellets that may have rubbed along the side of the barrel during discharge; but it would be almost impossible to obtain exactly similar test pellets by test firings, and in general, we may conclude that anything like advanced identification by means of using the microscope to show bore markings is out of the question. At best, the investigator is likely to be restricted to a determination of such factors as (a) The size and type of gun used; (b) The type and make of cartridge used, with a possible tracing of its ownership; (c) the exact size and type of shot involved; (d) in case empty shells are found, a microscopic comparison with test cartridges to see whether or not the breech-face markings on the primer or brass shell-head correspond; (e) from an examination of the wound and a knowledge of the type of gun and load, an idea as to the distance from which the shot was fired, etc. Sometimes these things will result in a complete solution of the case; but even when the evidence thus developed is not sufficient to obtain a conviction in court, it may very well be, and usually is, the means of bringing the preliminary investigation to a satisfactory conclusion, or helping to complete a known chain of circumstances.

Of course, in many such cases, there will be little enough for the investigator to work upon. If by luck, a repeating or automatic shotgun was involved, there will most likely be fired cases left at the scene; even when the guilty person used a single or a double barrel gun, he often reloads at once from force of habit or stress of excitement, and in doing so, forgets the empties ejected onto the ground. Any such fired cases will show pretty definitely the type of gun employed. The extractor and ejector marks will enable the skilled investigator to determine this point with accuracy. Also, the fired shells will most likely show the usual definite breech-face markings on the primer, and will give an opportunity to connect the fired cases positively with the gun involved, if the right gun comes under examination. Both the matter of extractor markings on the base of the shell and the breech markings on the fired primer have been treated at some length elsewhere in this book.

As has already been mentioned, there are several different sizes, or gauges of shotgun in use, and with a difference in the size of the gun or cartridge used, one might expect a variation in the size of the hole made by the mass of shot in striking an object at short range. There is, however, another factor which may enter into consideration, and this is the "choke" or degree of constriction employed at the muzzle of the gun to hold the shot charge together and keep it from spreading too much to be effective at the longer ranges. Shotguns come bored in three general degrees of choke; full choke, modified choke, and cylinder bore. These degrees of muzzle constriction are determined by the pattern requirements at the standard testing range of 40 yards. Thus, a cylinder bore is a barrel which will put approximately 50% of the total number of pellets in its charge into a 30 inch circle at 40 yards; a modified choke is one which will place 60% in the same circle; while a full choke will concentrate 70% of the charge within that circle at the same distance. These specifications seem very definite and exacting when set down in cold print; but in actual practice, each shotgun manufacturer has his own ideas and specifications as to what constitutes each degree of boring. In addition, different sizes of shot, styles of wadding, and loadings of powder will make a difference of several percent in the amount of shot thrown into the required circle by an individual gun; and a pattern may be varied as much as 5% to 7% by the use of a longer or shorter shell than the one that the chamber of the gun was intended for. So the careful investigator will do well not to place too much dependence upon the degree of choke which happens to be stamped on the side of the barrel of any gun under investigation. The writer's experience has been, particularly in the case of the lower priced shotguns, that the maker is likely to fire a shot or two through the finished gun, and then stamp it with whatever degree of choke it happens to pattern closest to. But another make of ammunition or size of shot may give an entirely different result.

Regardless of the degree of choke, there seems to be very little difference in the size of the patterns made by the different constrictions until a range of about 20 feet is reached. After the charge has traveled some 10 to 15 yards, the pattern begins to widen out rapidly, and from there on there is a difference between the size of the patterns obtained with the various degrees of choke.

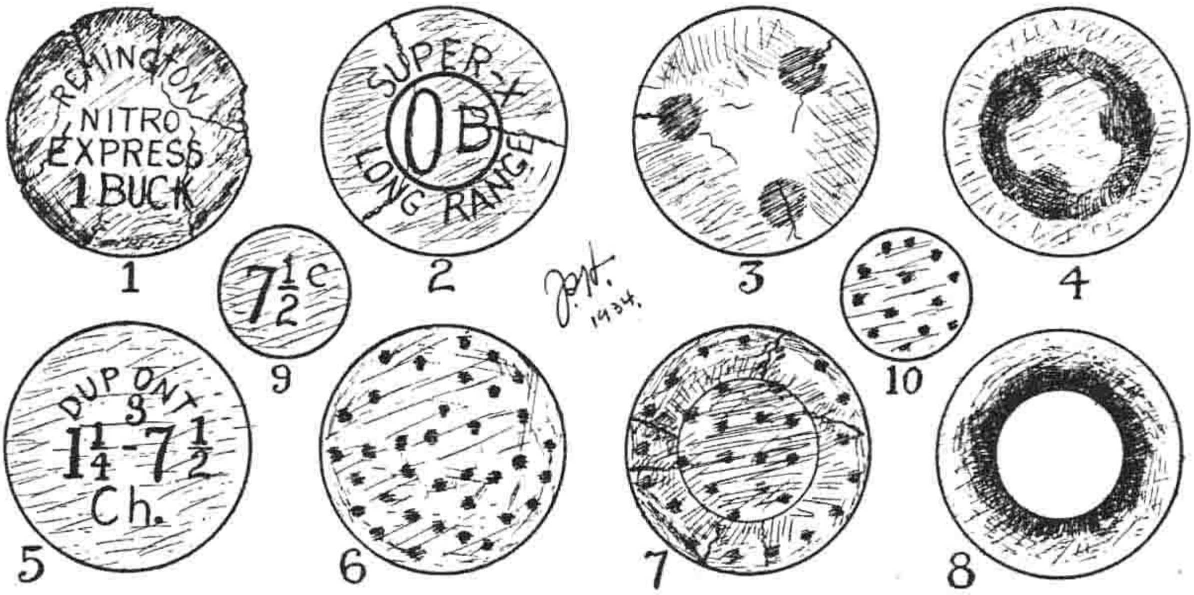
Action and Effect of Wadding

Even with the knowledge given previously as to chokes, patterns, ranges, etc., the investigator is still not fully equipped to determine the particulars under which a shotgun wound was inflicted; for there is another factor which may be of decided help in the investigation, and that is the action of the various wads with which the charge is loaded into the shotgun shell. It is the writer's opinion that this matter of gun wadding has not been given its due consideration in a majority of the shotgun homicides committed in the past, and that a more familiar acquaintance with the principles and action of such components would have assisted greatly in the correct solution of many such crimes. Very frequently it happens that by the time a qualified investigator arrives at the scene of a shooting, the wads will be the only definite evidence remaining available, the body and other evidence having been removed before his arrival.

The wads in a shotgun cartridge are blown out of the gun with the charge, but because they are of lighter material, they do not as a rule, go very far from the gun muzzle; and in almost every instance, some of these wads can be found if a close enough search be made, and if conditions be such as to make possible their recovery. Recovered wads do not offer a positive means of identifying the individual gun or cartridge from which they were fired, but they can give a tremendous lot of helpful information; such as a positive indication of the gauge of the gun used, and certain of the wads, if recovered, may show definitely what size of shot was used and the make of ammunition they came from.

If the reader will study the sketch of a shotgun shell on page 212, he will note that there are four different wads of three distinct types used. First comes the wad labeled No. 1 in the drawing, which is the "over powder" or "grease proof" wad; this is generally a thick cardboard wad made up of several layers of paper to a total thickness of about one eighth inch. This wad is invariably the easiest of all to recover, as it generally has its layers blown apart and scattered over the ground close to the gun, the wad or its layers are of full bore diameter but when recovered will not tell much other than the bore of the gun. Not all makes of ammunition use a thick cardboard wad in this place; some of the more modern, dense, smokeless powders are not affected by the presence of oil or grease from the wadding and the manufacturer merely uses an ordinarily felt wad here, which will next be described.

Next in order come wads Nos. 2 and 3, which are the "filler" or "black edge" wads; these are thick, elastic, and somewhat soft wads of felt or hair composition, and they are generally one-half or a full size larger than the bore of the gun; thus a 12 gauge gun may use 11 gauge wadding. These No. 2 and 3 wads are at times very hard to recover, as their action is erratic and depends upon circumstances; if fired at long range in the open they generally travel along with the shot charge to a distance of about 25 feet and then drop back and may trail along in the wake of the charge for some distance. But if fired at comparatively short range where the shot charge strikes against an object, these wads will also strike this object; and they may either penetrate or adhere to it, or rebound and be found somewhere between the target and where the gun was fired. In general these wads are not blown apart, though they may be swelled or distorted; but if recovered, they will show the gun gauge, and they may indicate the exact make of ammunition used. There is a variation in the composition, type and appearance of the different makes of felt wadding, as well as the methods of assembling the wads, and the manufacturer of the wadding or the make of the shell from which it was fired may readily be traced by the careful investigator. Look closely for the No. 3 wad, and if it is found examine it carefully; generally one surface (which was the upper one as it was loaded into the shell) is deeply dented with the imprints of the bottom



SHOTGUN WADS.

1. Top shot wad picked up at the scene of a shooting. It happens that in this case a repeating shotgun was used, and the empty cases were also recovered, but it will be seen how important the information given on this wad might be in any case. This particular wad was badly smoked up, and the bottom layer of paper was blown entirely off.

2. Top shot wad removed from an unfired buckshot load of another make. It will be observed that this wad gives the maker's trade mark, and the size of the shot; namely, No. 0 Buck. This wad is of thin cardboard.

3. Bottom surface of the wad shown as No. 2. Note the marks made by the top layer of three buck shot. There were twelve pellets in this load, in four layers of three pellets each.

4. Under shot wad from the same shell. This wad is made of compressed cork composition, and is deeply cupped on both sides. The impressions of the three pellets forming the bottom layer of buckshot are plainly seen and the wad is about a quarter of an inch thick.

5. Top shot wad from an ordinary trap load. Note the complete details given as to the load; 3 drams of DuPont powder and 1¼ ounces of No. 7½ chilled shot. The maker's name does not appear on this wad; it is from a Peters "Target" shell.

6. Bottom side of No. 5, showing the impressions of the top layer of shot. This is an accurate sketch of the exact manner in which the spots appeared, the somewhat open places indicating where the shot was bridged over so that no pellet touched right there.

7. Top surface of the under shot wad from this same No. 5 and No. 6 shell. This is a felt wad with a paper surface on each side. The top surface is deeply cupped, or pressed in, by the rammer used to seat the wad firmly in loading the shell. The marks of the individual pellets comprising the bottom layer of shot can be plainly seen, and if the wad were recovered after being fired these marks might show as deep indentations covering the entire surface. Wad is about a quarter of an inch in thickness.

8. Thick cardboard ring, or doughnut shaped wad used over the top of the one round, lead ball in a 12 gauge, single ball load. The end of the paper case is crimped over this ring (making it a top shot wad), thus centering and holding it in place. In the loaded shell, the surface of the ball can plainly be seen through the opening in the wad, thus clearly showing that it is a single ball cartridge.

9. Top shot wad from a .410 shell. Note that no information is printed on this wad except the size and kind of shot; namely, No. 7½ chilled. This is from a 3-inch Western Super-X shell.

10. Bottom surface of No. 9, showing the impressions of the pellets forming the top layer. Some makers print the load specifications on both sides of the top shot wad.

layer of shot, and these imprints will be a definite indication as to the exact size of the shot which the shell contained.

Last of all, one may recover the No. 4, or "top shot" wad. This wad contains the most readily accessible information of any, because one or both of its sides will be imprinted with the manufacturer's name or trade mark, the size and kind of shot used, and possibly with full particulars as to the kind and amount of both powder and shot. This No. 4 wad is also of exact bore size. The chances of recovering this particular wad are about 50-50, as it will be blown to pieces about half the time, but the recovery of even a part of this wad will be of immense help to the investigator.

The action, location and consequent recovery of any sections or pieces of fired gun wadding will depend to a great degree upon conditions at time of firing, both as to immediate surroundings and range at which the shot is fired, and also upon the ballistic qualities and components of the particular load being fired. The more powerful the cartridge, the further will the wadding travel, also the greater possibility of certain wads being blown apart. As a rule, the various gauges act pretty much alike and there is no distinct difference in the ranging qualities of the wadding from one bore over that of another. When any shotgun is fired, the wads travel along with or behind the shot charge for a short distance, then they trail along in the wake of the charge for a few feet or yards, and then drop and fall to the ground. As a general rule, the wadding stays with the charge up to about 20 feet, though this figure is approximate only, as it may drop at 15 feet or stay until the 25 foot point is reached. Even these figures are not stated as exact limits, but rather to give an idea of about what may be expected, both in the way of average distance, and of variations in that distance. Very sharp limits cannot be fixed, because the No. 3 wad in particular may become sufficiently imbedded in the shot charge to cause it to be carried along some distance further than the other wads. But if portions of the wadding be found in the victim's body, or in the clothing around the wound, it is an almost certain indication that the shot was fired at a range of less than 30 feet. The proper method of ascertaining this point would be to obtain exactly similar cartridges to those involved in the crime, and then to fire them in the actual gun that was used, at various close ranges, and see definitely just where the wadding drops away and how it acts.

Somewhere between the 20 foot and 30 foot range, the wadding will drop away from the shot charge, and for another brief space will trail along in its wake. At this stage of its travel, the action of the wadding is very erratic, something on the order of a bullet which has glanced and become a ricochet; should any of the wads happen to strike the target they still have sufficient force to rebound and may bounce off in any direction for a few yards. Also they may become considerably deflected by a strong wind and be blown off to one side or the other, or even carried ahead of the target itself. Hence it is not a safe procedure to place too much reliance upon the position of any particular pieces of wadding as an exact indication as to where the shot was fired from; unless, as stated previously, pieces of the wadding should be found in the wound or lodged in the victims clothing.

Not all styles of shotshell wadding will act as described, for there have been, and may still be, a few kinds of cheap wadding which will blow apart as soon as it leaves the muzzle of the gun. But the manufacturers try to avoid this kind of wadding, as its disintegration permits the muzzle blast to blow into the shot charge and spoil the pattern. In general, the aim is to obtain a light and soft material which will hold together and serve as a cushion to the powder gases while their force is being transmitted to the shot column, and until the charge has gotten away from the muzzle of the gun, after which the wadding should drop away as quickly as possible. Heavy and hard wads are undesirable, as they are likely to blow up into the shot charge as it leaves the muzzle, and will spoil the pattern.

Range at Which the Shot Was Fired

All this is leading up to a discussion of the possibility of being able to state how far away the gun was when it was fired; or in case the exact distance is known, then of being able to state what gauge and choke of gun to look for. This latter point is liable to be of considerable importance in the case of a shot fired from amongst a crowd of armed men, or in case of a question as to which of two individuals fired the fatal shot at a third party. Such a matter is naturally tied up considerably with the general characteristics of shotguns and their action as regards ranging power, spread of pattern, exact ammunition used, shot sizes, etc.

The shotgun is, as stated before, capable of making horrible and most deadly wounds when fired within a range of a few feet. At these short ranges, the bulk of the charge is still traveling together as a mass, but as the distance increases the outermost pellets begin to separate from the main nucleus, and by the time the charge has gone 10 or 12 feet the total spread might be as much as 3 to 5 inches. By the time it has gone 20 feet, the most of the shot are still massed in one group, but the outermost ones have gone several inches out to the sides, and the total spread is perhaps 7 to 10 inches. Up to, and possibly a few feet beyond this point, there is much to be learned from the action of the wadding, a subject which has previously been gone into.

After the charge has gone 10 yards or so, the load of shot is generally moving along free of all wads, and is no longer bunched together in a compact mass; instead, it rapidly spreads more and more from that point on out to the extreme range of the gun and load. From this range of 10 or 15 yards onward, the investigator must depend upon the extent of the spread of the charge and upon the density or concentration of the pattern to arrive at even an approximate idea of the range at which the shot was fired. The word "approximate" is used advisedly, for even when the exact gauge of the gun and character of the load are fully known, any deduction of the range from these factors, based upon previous experience where the human being was the target, will be little better than a reasonable estimate, which may differ considerably from the exact figures sought, though certainly a general idea that may be very helpful can often be obtained.

This idea that it should be possible for an expert to state the exact range at which the shot was fired by an examination of the pattern made by the charge is a very common fallacy even amongst experienced shooters; but in actual practice it is a most indefinite problem under the most favorable conditions, and is one on which a mistaken conclusion may readily be made. Yet the court trials of the past have been full of evidence as to the exact manner in which a certain type of shotgun would "spread" or "bunch" its charge at various stated distances, much of which would be read with amazement by anyone who had experimented at length on this subject.

When a shotgun pattern has been fired onto a sheet of plain paper, it looks rather easy to strike off the standard sized circle, cross-section the paper into squares, and in this manner count its pellets and analyze the percentage performance for the given choke and range; and conversely, with a gun of known performance with a particular charge, it would theoretically be possible to estimate the range very closely by this means. But in actual practice, even under these fixed and artificial conditions, the problem may be unexpectedly difficult. To illustrate, a charge of one ounce of No. 4 soft shot contains 132 pellets, and a barrel with modified choke will put 79 of these pellets into the 30 inch circle at 40 yards range, while the full choke barrel will pattern 93 pellets. Thus the difference between these two standard degrees of choke is but 14 pellets, and these 14 are distributed over the entire area of the 30 inch circle, which is more than 700 square inches. Thus there would be only one additional pellet per 50 square inches of area, and the difference would not be perceptible to the unaided eye, especially when only a small part of the pattern is examined, as will be the case when a person is shot at any but short range. It is impossible to find any portion of the human anatomy that even approaches the area of a 30 inch circle, and moreover, the charge of shot is nowhere near centered on the human being in the average case. Indeed, most shotgun patterns vary considerably in their density, one sector possibly having its holes close together, while the next sector may have them spread quite thin. For these reasons, among others, it is not often possible to give an opinion which is anything but an approximation, as was stated above.

Where the smaller sizes of shot are concerned, the 6, 7, 7½ and 8 sizes, it is an easier matter to determine pattern characteristics and density upon the paper target, particularly with the two latter sizes. There is a much heavier concentration of shot holes and the mass looks more even to the eye, also the totals and proportions run into more impressive figures on account of the far greater number of pellets. But small shot will only kill small game. It is very unlikely that any size smaller than No. 4 would prove effective, or would be deliberately used upon a human target under most circumstances.

Yet if he knows exactly what gun and cartridge was used, it is readily possible for the skilled investigator to arrive at certain deductions with assurance. Thus it can usually be ascertained, by the indications of the pattern alone, whether a shot was fired at less than 5 feet, between 5 and 25 feet, between 25 and 50 feet, between 50 feet and 40 yards, or over 40 yards. It is the writer's opinion that one can hardly determine with assurance a distance of less than 5 yards by pattern analysis alone, and only the exceptionally skilled expert can come this close; and this is assuming that he is in full possession of accurate data as to the gun and ammunition used. At best one will be doing well to be able to state with certainty that the gun was fired at "close," "short," "mid" or "long" range, always keeping in mind that the killing range of the shotgun against human targets is generally less than 50 yards.

Evidence from Size of the Wound

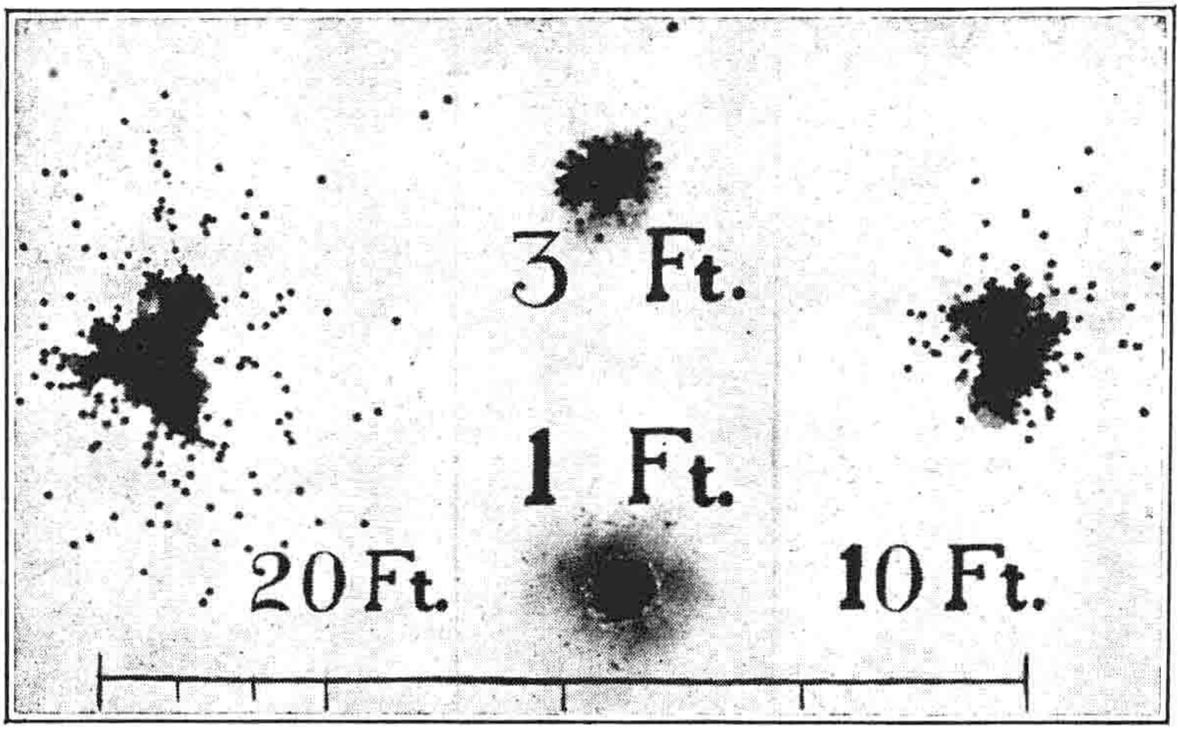
It will be quite apparent from what has been said above, that valuable indications as to the range at which the shot was fired, or if the range is known, then as to the type of gun used, may often be obtained from the character and extent of the wound inflicted by a shotgun. However, it will also be plain that this method also has its serious limitations.

In the first place, any attempt to determine the bore of the gun from the exact size of the hole made at extremely close ranges of a few inches would be futile. The bore diameter of a 12 gauge gun is .729 inch, while that of the 16 gauge is .662, and that of the 20 gauge is .615 inch. Thus it will be seen that the actual difference in diameter between the 12, which is generally considered to be a large size, and the 20, which is considered small, is only a little over a tenth of an inch. But the opening up of the shot charge, coupled with the terribly destructive nature of the wound, make a determination of the size of the wound within any such limits totally impracticable. Under such circumstances, the wads should be recovered and the determination of the gauge of the gun should be based on their dimensions, or on the markings of the top shot wad if the investigator is lucky enough to recover it.

At ranges under five feet, the entire charge, wads and all, would enter the body in practically a solid mass, making but one wound of entrance, a "rat-hole" from one to two inches in diameter. Most self-inflicted hunting wounds are of this nature, for the muzzle of the gun is almost certain to be very close to the body.

At a range of around ten feet, the same kind of "rat-hole" is in evidence, for the charge is still travelling in a compact mass, but with this difference, that a few straggling pellets have begun to wander off to the sides. Thus the total spread would be from 3 to 5 inches, with 4 as a probable average. There is still the one main hole, into which the bulk of the shot have penetrated in a mass, and the wads will be accompanying the charge, or remain at least sticking in the wound.

When the 20 foot point is reached, there still persists the general effect of a main wound containing most of the shot, but the number of pellets which have spread to the sides have greatly increased, and the extreme spread of the isolated pellets around the main wound will be from 7 to 10 inches. The wads will have commenced to drop away from the charge, and most likely will strike the clothing a few inches away from the main pattern, though quite possibly one or more of them may carry on into the wound.



Series of single shots fired from a 12 gauge shotgun, modified choke barrel; with gun muzzle above exact distances from the white cardboard target. Load was 1¼ ounces of # 5 chilled shot, with 3½ drams smokeless powder in Remington case, factory loading. In each of the shots fired above the wadding was blown through the main, centrally located hole in the cardboard. Soale represents one foot, with inches designated at the left.

At these short ranges of under 20 feet, it is seldom possible to tell much from the pattern spread, penetration, or power, for the pellets are massed so closely together that they pulp or destroy the tissue and surrounding area too thoroughly to enable the effect of individual shot holes to be studied. One can better be guided by the total extent of the wound area, the action of the wadding, and other known facts.

A final and very limited means of identification with shotguns will be an examination of the shot pellets recovered from the victim's body. This will show the size of the shot, and the type; that is, whether it is soft or drop shot, or is chilled or coppered.

Use of Buckshot

When the owner of a shotgun intends to use it against a human being, he seldom uses the small or hunting sizes of shot; unless the shooting is done on the spur of the moment, or the killing is planned to be at very close range. When the use of a shotgun is premeditated, the user is very likely to use buckshot, and right here is where the shooter usually makes a serious error in his calculations, because buckshot are notoriously unreliable at any but the very shortest of ranges. The great fault of buckshot is the limited number of pellets comprising the load, and the fact that these few pellets fly apart and scatter badly, so that they cannot be placed with any degree of certainty, as can a rifle or revolver bullet. Buckshot at ranges of 50 yards or more cover a pretty wide pattern, and if they do not miss the intended victim entirely, they are more likely to wound than to kill. However, there is much ignorance on this subject, and the majority of shooters have a highly exaggerated idea of the efficiency of buckshot, and will use them at ranges and for purposes where they are woefully impotent.

In the loading of buckshot cartridges, the ammunition companies are obliged to take into consideration the fact that the pellets must be arranged in regular layers in the shell, and that these layers must pass through the choke without jamming and probably splitting open the muzzle of the gun. Therefore, the layers of pellets must "chamber" properly as they pass through the choke, and this means that not every combination of pellet size which will lie in the shell will go through the choke. Certain combinations cannot be made to work safely. For instance: No. 1 Buck size is not loaded in 10 gauge shells, nor is No. 0 Buck safe to use in 16 gauge cases. The 20 gauge cartridge has been loaded with only Nos. 1, 2 and 3 Buck sizes. Furthermore, there is a set relation between the size and the number of pellets which can be loaded into a certain gauge of shell, and this number is seldom varied by the manufacturer. These set factors should be given consideration in investigating a shooting committed with buckshot, as the presence of a certain number of pellets of a given size of buckshot can either indicate or eliminate a particular gauge of shotgun.

One important point about buckshot for the investigator to consider is the fact that they are used very sparingly in actual hunting, and a sportsman who may do a considerable amount of shooting and use up several hundred shotgun shells in a season is not likely to use more than five or six buckshot cartridges in the same time, if indeed, he uses any at all. Also, there exists among the better sportsmen a very considerable prejudice against buckshot, and many of them would not want to be found with a buckshot cartridge in their possession. These facts may often make possible the easy tracing of buckshot cartridges. The use of single ball cartridges in shotguns is even rarer than the use of buckshot.

MISCELLANEOUS INFORMATION REGARDING ARMS AND THEIR EFFECTS

We will now leave the subject of wounds, which belongs more particularly to the domain of the coroner, and return to the subject of the effects and peculiarities of guns, and what may be expected under various conditions. The individual who aspires to qualify as an expert on all kinds of firearms will want to know everything that has already been said in this book about guns and ammunition, and in addition, he must learn to become really interested in all phases of the subject. The catalogs of all the leading makers of firearms should be thoroughly studied, and the well known and very interesting books on the subject of firearms should be read. All this should be supplemented by a first hand familiarity with the various guns and their effects, that can only be obtained by actually using and experimenting with them constantly.

An attempt will be made here to set down some of the things that such an experimenter will need to know, but which are somewhat difficult to find elsewhere.

The Extreme Range of Guns

Very often the question may arise of how far the various guns will send a ball, or in other words, what is the extreme range. This varies with the initial velocity, the weight of the bullet, its cross section, and the angle of elevation at which it is fired. The modern rifle bullet will attain its greatest range when it is discharged at an angle of elevation of about 30 degrees; and a slight variation of this angle of elevation at the extreme range does not change it much. On the other hand, a slight change at a short range will make a great difference. For example, with the .30 caliber M-1 ammunition used in the Army, an elevation of 29° 05′ gives a range of 5500 yards, and its requires an additional six degrees and five minutes to gain an additional 100 yards to 5600, which is about the maximum; while to gain an additional 100 yards from 100 to 200, requires an additional elevation of but 3 minutes; 2 minutes elevation giving 100 yards, and 5 minutes elevation giving 200.

Comparatively few cartridges have been carefully fired to determine the actual extreme range, but almost all cartridges have had their extreme range calculated by one method or another. Generally, when the actual firing is made, the maximun range is found to be less than it was calculated to be. Thus the Springfield rifle, with the 1906 cartridge was fired at various ranges up to 1500 yards on actual targets; and at the longer range the difficulty of getting on the target, and the variations caused by the wind caused the results to be only approximate. From these results the extreme range was calculated to be 4500 yards. But the author tried for himself to see how far the Springfield would shoot, soon after its adoption by the army, and shooting over water in Florida in 1911, was unable to obtain anything like this range. When, at the beginning of the World War, he was placed in charge of small arms engineering for the War Department, he caused experiments to be started to determine this point, with the object of obtaining correct data for machine gun fire control tables. The experiments, conducted by firing with machine guns on water, disclosed the fact that the Springfield rifle with the 1906 ammunition would shoot only 3400 yards at the maximum.

These early experiments, conducted by Major G. P. Wilhelm, at Borden Brook, Mass., were supplemented by later ones at Miami and Daytona, Florida, carried out by Major Wilhelm and Captain Crossman, with several assistants. These experiments definitely showed that the extreme range of the Springfield rifle with the 1906 cartridge, 150 grain bullet and 2700 feet per second muzzle velocity, is not over 3400 yards, and that the extreme range of the present .30 caliber M-1 cartridge with the 172 grain boat tail bullet and 2640 feet per second muzzle velocity is about 5600 yards, or a little over three miles.

Low powered hunting rifles, such as the .38-40 and the .44-40 will carry about 1800 yards, or a little over a mile, as will the high velocity .22 long rifle cartridge, which is marked inside the lid of the carton in some makes, "Dangerous within 1 mile." Medium and high powered hunting rifles will carry from 2000 to 3500 yards, The ordinary, or low velocity .22 caliber long rifle ammunition, having a muzzle velocity around 1080 f.s. will carry to an extreme range of between 1300 and 1400 yards, when fired at an elevation of around 30 degrees.

A case is on record where a boy was killed with a .22 short fired from a cheap and rusty gun at a range of 639 yards, or very nearly ⅜ of a mile; the length of three long city blocks.

The author has fired the .45 automatic pistol on the big iron target that used to be on the Watershops Pond at Springfield Armory at a range of 1100 yards, and obtained many hits; and has obtained hits on this target at the same distance with the .22 long rifle.

The extreme range of the .45 automatic is about 1600 yards, or just short of a mile; the super .38 and the .38/44 and .357 Magnum will go over 2000 yards. Pocket revolvers, such as the .38 S & W and the others of similar size will go over a thousand yards.

The average individual, as a rule, seldom has any idea that the extreme range of rifle and revolver cartridges is as great as is actually the case. Most persons are amazed to learn that the ordinary .22 caliber small-boy's rifle can fire cartridges which will travel for a mile or more, or that the average small pocket revolver will shoot and may kill at almost three-quarters of that distance. In the past, many statements have been introduced through such persons to show that the homicide in question could not have been caused by the accused, as he was, in their opinion, too far removed from the deceased to have delivered the fatal shot. When questions of this nature arise, actual check tests made with the cartridges and weapons in question will soon settle the debated point very clearly.

The figures for the extreme range of the various cartridges are useful chiefly to give an outside limit beyond which the weapon and cartridge in question cannot possibly be blamed for the shooting; the mere statement of these figures may give a very misleading idea of the *probabilities* in any given case, unless the reader takes into account the fact that the total range of any weapon is divided into several zones or stages.

First, there is the zone which lies relatively close to the muzzle of the gun, and within which it is easy for anyone to make a hit, even if he is not a skilled shot. A woman who has never used any kind of firearm in her life can hardly miss at a range of two or three feet, and many crimes of passion with pistols are committed at such short ranges.

Next comes the zone lying somewhat further away, in which the weapon and cartridge in question is capable of delivering its normal accuracy, and with in which a skilled shot is nearly certain to make a hit. With pistols and revolvers, this zone covers the distance from the muzzle to about 50 or 100 yards away, depending on the weapon used. With rifles, this zone may extend to ranges of from 200 to 500 or more yards, depending on the weapon and the conditions of use.

Beyond this is a zone where the bullet will still be effective if a hit can be made, and within which accidental killings are possible. For pistols and revolvers, this zone will extend to perhaps 1000 yards or more, and with rifles of the high powered or military type, it will reach to a distance of over two miles.

From there on to the point where the spent bullet falls to the ground, there is a zone in which the bullet may inflict more or less serious injury if it happens to hit a living object, but in which it has spent most of its velocity, and lacks power to kill unless the victim is struck in an exceptionally vulnerable spot.

Penetration

The ordinary measure of penetration, as given in the catalogs of the gun and ammunition makers is the number of white pine boards ⅞ inch thick, and spaced 1 inch apart, that the bullet will penetrate. Many years ago, the Ordnance Department decided that a bullet that would penetrate 1 inch of pine would be capable of inflicting serious injury on personnel, and in connection with the tables of penetration in a number of the old Ordnance pamphlets will be found the statement "A penetration of 1 inch in white pine corresponds to a dangerous wound."

When a solid block of wood is used as a test of penetration, instead of a series of boards, separated by spaces, the distance penetrated is much less; for as the bullet plows its ways through the tough material, a part of the wood piles up around the nose of the bullet, and becomes wedged ahead of the point. When a solid block is used, this action is continuous, until such time as the bullet comes to a halt; but when spaced boards are used, this wedged material is allowed to escape from around the nose of the bullet each time one of the spaces between the boards is reached. Solid green wood, such as the trunk of an oak tree, is very effective in stopping any bullet.

Sand is a very effective material for stopping the penetration of bullets; dry sand is better than wet sand, because the water in the wet material acts as a lubricant, and assists the bullet to slip through more easily. Earth or loam is less effective than sand.

The following figures for penetration of various weapons in different materials are taken from the Ordnance Department Pamphlets on the weapons in question. The tables for the Springfield rifle are equally applicable to the Browning machine gun, the Browning automatic rifle, or the Colt monitor.

TABLE OF PENETRATION FOR SPRINGFIELD RIFLE WITH .30 CAL. AMMUNITION MODEL OF 1906, (150 Grain Bullet, 2700 f.s. muzzle velocity).

MATERIAL	PENETRATION			
	50 feet	100 yards	500 yards	1000 yards
	inches	inches	inches	inches
1 inch white pine boards 1 inch apart	59.98	52.8	26.36	10.48
Moist Sand	10.06	14.02	16.1	13.9
Dry Sand	6.32	6.88	13.12	10.86
Loam, practically free from sand	19.9	17.46	23.62	17.46
Thoroughly seasoned oak, across the grain	34.19	31.18	14.32	------------
Brick wall	------------	5.5	------------	------------
Boiler plate steel	.528	.40	.10	.0

The reader will at once notice that the penetration in sand is greater at the long ranges than it is close to the gun. There are two factors having a bearing on this. One is the fact that when the bullet is fired into sand with a very high velocity, the jacket will be stripped off and the lead core volatilized. At slower velocities, this violent action does not occur, and the penetration is greater. The other factor is the stability of the bullet. In the early parts of its flight, it has a decided tendency, from the reaction of its gyrostatic action on encountering a resistance, to turn so that it is going more or less sideways. This tipping action is largely affected by the density of the object it encounters, and the amount of "yaw" or deviation from the line of trajectory that the bullet has at that part of the trajectory where the resistance is located.

When hunting arms are tested for penetration, for the purpose of obtaining catalog data, the test is usually made only at or near the muzzle, for it is an expensive and difficult job to make such tests at the long ranges; for this reason the data published by the Ordnance Department in their pamphlets will give valuable information that cannot easily be obtained elsewhere. For that reason the figures covering two of the former army cartridges that are still much used in hunting are given below.

PENETRATION TABLE FOR THE .45 CALIBER SPRINGFIELD RIFLE AND CARBINE

The rifle, (32.6 inch barrel), uses the .45-70-500 cartridge, with bullet lead weighing 500 grains and having a muzzle velocity of 1316 feet per second. The maximum range is 3500 yards, at an elevation of 29° 45′ 36″. The time of flight for the maximum range is 21.2 seconds, and the penetration in sand at this range is 10 inches.

The carbine, (22 inch barrel), uses the .45-55-405 cartridge, with a 405 grain bullet and a muzzle velocity of 1150 feet per second. The maximum range is about 2800 yards.

PENETRATION IN WHITE PINE. (Inches)

	100 yds.	200 yds.	300 yds.	500 yds.	700 yds.	1500 yds.	2000 yds.	2500 yds.
Rifle	19.1	16.5	14.1	10.6	9.0	--------	--------	--------
Carbine	14.5	11.4	9.3	7.25	6.3	3.0	1.5	1.3

PENETRATION TABLE FOR THE .30 CALIBER KRAG-JORGENSEN RIFLE AND CARBINE

Both rifle and carbine use the .30 U. S. Army cartridge, sometimes called the .30-40 Krag. It has a jacketed bullet weighing 220 grains. The muzzle velocity with the rifle, having the (30-inch barrrel), is 2000 f.s., and with the carbine, (22 inch barrel), is 1920 f.s. The penetration, as given below, is in 1 inch pine boards spaced 1 inch apart.

PENETRATION TABLE.

	53 feet from muzzle	500 ards	1000 yards
Rifle	45.8 inches	19.85 inches	11.44 inches
Carbine		17.96 inches	11.02 inches

Penetration of Pistol Cartridges

The .45 caliber automatic pistol cartridge will penetrate 6 inches of pine wood at 25 yards, and 4 inches at 250 yards. It will penetrate 9.95 inches of moist loam or 7.8 inches of dry sand at 25 yards. Note that the pistol will thus penetrate more dry sand at this range than will the high powered rifle; the very high velocity of the rifle bullet tears it to pieces before it can do much penetrating.

For other figures on the penetration of pistol bullets, see the section on Ammunition of the TEXTBOOK OF PISTOLS AND REVOLVERS, and particularly pages 350, 370, 374, 376, and the table of penetration on page 321.

Penetration in Water

Water rapidly reduces the velocity of a bullet of any caliber fired into it. A high powered military rifle will have the velocity of the ball reduced to a harmless figure by a penetration in water of about 7 feet. A .22 short will penetrate about 24 inches. The average revolver bullet is rendered harmless by a thickness of four feet of water.

In experimenting on the penetration of bullets in water, the author conducted the rather startling experiment of placing a .22 caliber rifle entirely under the water, so that the barrel was full, and then firing the rifle at various objects. There was no noise, but a bubble of gas rose from the gun at each shot. At short distances, it was easy to hit objects under the water in this way, but with the .22 long rifle no great penetration was secured at distances in excess of 15 inches.

In a paragraph on a preceding page, the writer stated that the average individual is prone to underestimate the extreme ranging powers of all modern cartridges. Strangely enough, his ideas as to penetration are just the opposite, and he is much given to overestimating the effect of almost any high-power ammunition when it comes to shooting it into wood, flesh, metal or almost any ordinary material; and his opinion is generally given accordingly.

Ricochets

When a bullet is fired so that it strikes a surface at an angle, it may either penetrate, or bounce off and continue on in a new direction. When a bullet bounces off a surface in this way, it is said to *ricochet* (pronounced rick-o-shay). On ordinary ground the bullet will generally penetrate if it strikes at an angle greater than 15 degrees; but there is nothing certain about this, and a dogmatic statement as to what the angle is beyond which a ricochet will not occur should not be made, for it is always possible for the bullet to strike a slight irregularity in the ground, which will greatly change the actual angle at the point where the bullet touches the surface. The same effect may be caused by the presence of a small pebble at the point where the bullet strikes.

Again the tendency to ricochet is very much affected by the shape of the point of the bullet. A round pointed bullet will tend to ricochet easily, and a square pointed one will be more likely to bite in.

On cement or macadamized roadways and pavements, ricochets occur with great ease, and it is not uncommon to read of someone being killed when the policeman "Only fired on the ground to frighten him." A notable example of the power of a ricochet was given by the fatal accident which occurred in the fall of 1933, when the Cinema actor Russ Columbo was accidentally killed by the explosion of the charge in an old muzzle-loading pistol which was being kept as a curio. According to the newspaper accounts, a friend of the actor snapped the head of a match on the nipple of the gun, which was thought to be unloaded, and it went off, and the bullet struck a piece of furniture, and then bounced and struck the actor, wounding him fatally.

The danger from ricochets was used as the theme of a novel written sometime ago, in which one character of the book practiced ricocheting a ball off an old iron pot until he could tell just where it was going; then he waited until his enemy and several other people were all standing nearby, and proceeded, in the presence of witnesses, to allow his gun to be "accidentally" discharged so that the bullet struck the pot and bounced, killing his enemy. This story is hardly probable, because ricochets are not by any means so constant in their flight and direction; but the power of the ricochet for harm was not in the least exaggerated.

Ricochets will occur with regularity on water when the flight of the bullet makes a small angle with the surface. When the water has waves on it, there is no telling at what angle the bullet will strike the surface of the wave, so that there is always danger of a ricochet from almost any shot under these conditions.

The rotation of the bullet has a lot to do with the direction that the bullet takes after it comes in contact with the surface. Usually with a right hand twist to the rifling, the bullet will ricochet to the right, and vice versa.

"Keyhole" Shots

When the barrel of a rifled gun becomes very much worn, or if it becomes covered with a deposit of lead near the breech, as sometimes happens with insufficiently lubricated bullets, the gun will lose its accuracy, and very often the first symptom of such a condition is the failure of the bullets to fly point-on. If they go nearly point-on, they are said to *tip,* while if they turn so that the flat side of the bullet strikes the object, and makes an oblong hole, they are said to *keyhole.* In such a case, the bullets usually have no distinct land or groove marks on them, as they will have jumped the rifling.

Frequently, when very cheap revolvers are used in a crime, the barrel may be so worn or loose that there will be no land or groove marks at all on the bullet, even though the bullet may have received enough spin to keep it point-on. Within a week of writing this paragraph the author has examined under the microscope such a bullet from an old "Thames" revolver. While there were no land or groove marks visible, the surfaces of both evidence and test bullets were covered with fine spiral scratches, and identification was made without difficulty. Fortunately for the person who used the gun, the wound was not serious, and as it was a family affair, there was no prosecution. The identification merely prevented the police from being led on a wild-goose chase after a mythical assailant described in a story concocted by the victim in an effort to "cover up."

Ejection of Fired Cartridges

Machine guns, automatic rifles and automatic pistols eject their empty cases forcibly, and often throw them some distance away from the gun. The direction and length of the ejection is quite different with the various makes and types of automatic weapons, and it is frequently within the bounds of possibility that a knowledge of where the empty cases are likely to be found in relation to where the gun was when it was fired may be of great assistance to an investigator in solving a case. For example, a man is found dead in his sitting room on a warm summer night, with the outside door wide open; a passing policeman who hears a shot rushes up, finds an acquaintance bending over the dead man, and a .32 automatic pistol lying near the open door. The acquaintance claims that he had just entered on a call and was advancing to meet his friend, when the latter was shot through the open door. He is of course arrested for the murder. The alert investigator will at once attempt to locate the ejected cartridge case, for if it is found inside the room, it shows that the shot was fired from inside and that the accused is lying. On the other hand, if the empty case is found outside on the porch or lawn, it shows that at least that much of the story is true that places the location of the shooter outside; although the accused may still have fired the shot from the front walk before entering. Again, a political parade was recently fired upon by machine gun fire, with the resulting deaths of several persons, and the shots seemed to come from the direction of a house owned by the rival political boss. If the shots were actually fired from inside the house, it would look bad for the owner; but if they were proved to have been fired from a car parked outside the house, it could look as though an attempt were being made to "frame" the owner of the house. The exact place

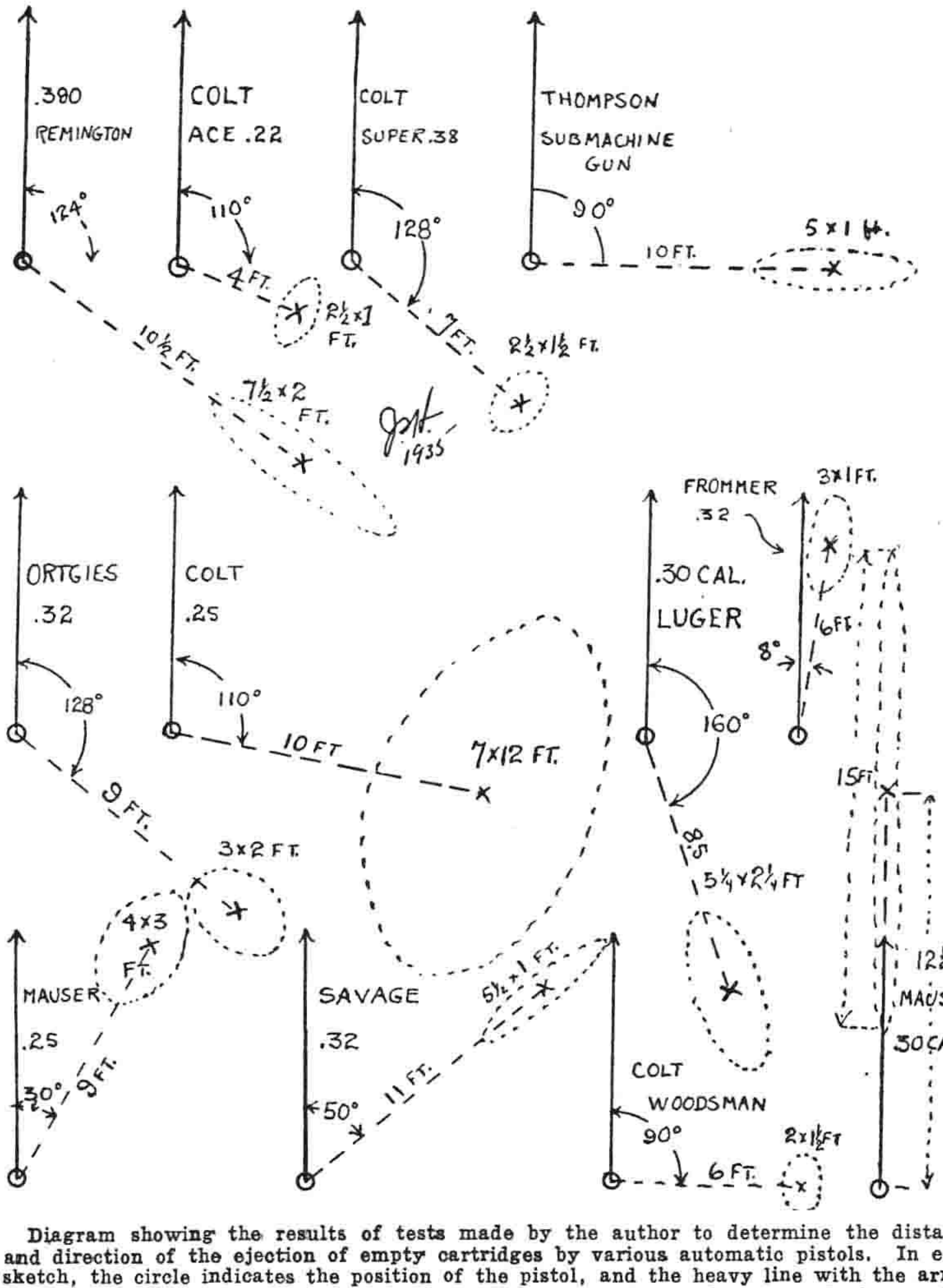

.380 REMINGTON
124°
10½ FT.
7½×2 FT.
COLT ACE .22
110°
4 FT.
2½×1 FT.
COLT SUPER .38
128°
7 FT.
2½×1½ FT.
THOMPSON SUBMACHINE GUN
90°
10 FT.
5×1 ft.
1935
FROMMER .32
3×1 FT.
16 FT.
8°
ORTGIES .32
128°
9 FT.
3×2 FT.
COLT .25
110°
10 FT
7×12 FT.
.30 CAL. LUGER
160°
8.5
5¼×2¼ FT
15 FT.
12½ FT
MAUSER .30 CAL.
MAUSER .25
4×3 FT.
30°
9 FT.
SAVAGE .32
50°
11 FT.
5½×1 FT.
COLT WOODSMAN
90°
6 FT.
2×1½ FT

Diagram showing the results of tests made by the author to determine the distance and direction of the ejection of empty cartridges by various automatic pistols. In each sketch, the circle indicates the position of the pistol, and the heavy line with the arrow at the end is the line of aim. Ten shots were fired with each arm, and the empties were found distributed over the areas enclosed by dotted lines.

where the ejected cases were found would have a great deal to do with the conclusions arrived at in this investigation.

Tests show that there is a wide variation in the characteristics of the different arms in regard to this distance and direction of ejection. Most automatic pistols throw the empties to the right, or to the right rear, but some of them eject almost straight upwards so that they fall just in front of the muzzle, while others throw them some distance directly in front of the muzzle. The Thompson submachine gun throws them straight out to the right, usually from seven to twelve feet. Some individual guns will throw their empties all into the same small area, thus showing great regularity of action; while others are variable and irregular, throwing one shell close, and another far, thus spreading the empties over quite a large space.

The .45 Colt Automatic pistol is in this latter class; the ejection of any one gun is somewhat irregular, and there is likely to be quite a variation between any two guns. This is accounted for by the fact that unlike the ordinary, non-military arms, the Government Model must be made strictly interchangeable, so that a certain part from any one pistol will replace a similar part in another pistol. This means that there will be variations in fit when a tight part is put into a loose gun, or vice-versa. Any change in the tension of the extractor or in the shape of the ejector will affect the distance and direction of the ejection; as will a variation in the loading of ammunition. The Government Model .45 Automatic "as issued" will throw the empties anywhere from nearly straight back to almost directly to the right, and the distance will be anywhere from almost under the gun to ten or twelve feet away. These results were obtained with guns which were selected at random from lots made at various factories under the stress of wartime production. Other automatic pistols, in which interchangeability of parts is not required, are usually hand fitted, and the ejection is likely to be more regular.

The author has made a number of tests with various pistols, and the results are plotted in the accompanying sketch. Owing to variations which may occur, this should be used merely as a guide, and if it is necessary to determine the position and angle of fire of the pistol from the location of the ejected empty cartridge, careful tests should be made with the actual pistol involved, using cartridges of the same make and lot number.

The Noise of Firearms

Everyone is familiar with the loud, characteristic report made when a firearm is discharged, but few know or realize that even if this report did not exist, there would in many cases be almost as much noise heard. This is because there are two other noises that accompany the report of a rifle or revolver, but which are in a way drowned out or masked by the louder report of the discharge. These are; first, the strike of the bullet, which often makes quite a loud noise by itself; and second, the noise made by the bullet in passing through the air, which occurs whenever its velocity exceeds that of sound. The velocity of sound is about 1080 feet per second under average atmospheric conditions, though it increases slightly when the temperature falls or the barometer rises, and decreases under the opposite conditions owing to the fact that this phenomenon is a function of the density of the air.

In the case of revolvers or automatic pistols, the majority of which fire cartridges having a velocity below that of sound (1080 f.s.), there will of necessity often be instances where only the report of the gun will be heard. For instance, when fired into an object close at hand, the sound made by the striking bullet will blend into that of the report, so that but one noise will actually be heard. And when fired at some far distant object, the range may be so great that the sound of the bullet strike will be imperceptible.

With a modern, high-power rifle of extreme velocity, such as the Springfield, it is readily possible to define the three separate noises by firing the arm over a range of 800-900 yards where acoustical features are suitable for the test to be made. The listener should be located about 600 yards in front of the rifle and the shot should be fired over his head. First, he will hear the sharp, whip-like crack of the bullet as it passes overhead through the air, and this will immediately be followed by the report of the rifle, a dull "plop" at that distance. Right on the heels of the rifle report will be heard the sound of the bullet strike; often a loud crashing sound.

It should be kept in mind that any bullet which starts its flight above the velocity of sound will make a characteristic bullet noise until its velocity has dropped below 1080 f.s., after which there will be no further noise until the sound of the strike. The strike alone of any high velocity bullet, when fired at short range, makes a very considerable crash; but it may blend into the report of the gun so perfectly as to pass unnoticed.

Silencers

A silencer (sometimes called a muffler), is a device like the muffler of an automobile, intended to be attached to the muzzle of a firearm to prevent or reduce its noise. For any rifle or pistol which gives its projectile a muzzle velocity less than that of sound, a silencer can be made which practically prevents all the noise of discharge; but which will not, of course, affect the slap which the bullet makes when it hits a nearby object. For revolvers, the silencer is not effective, detective stories to the contrary notwithstanding, because the gap between the cylinder and the barrel allows escape of gas with a resultant report. With the ordinary rifle of any kind, the muzzle velocity is likely to be over 1100 feet, and with them the silencer has little effectiveness, because the bullet itself makes a sharp crack in passing any sizable object. Any man in the Army or National Guard who has been in the target pits during rifle practice is familiar with this sharp, whip-like report, which is entirely separate from the dull "plop" of the rifle, heard some instants later. With the silencer in place, the report of the gun, which formerly drowned out this noise to all those near the firing point, is suppressed, and the bullet noise becomes sharply apparent. It seems to occur again each time the bullet passes some object which can reflect the sound waves back to the hearer. The author has experimented rather extensively with silencers on various arms, and it was most interesting to demonstrate this fact by firing first over a body of water, where one sharp report was heard, then turning and firing parallel to a line of telegraph poles, upon which a succession of reports was heard which sounded like a short burst from a machine gun. At one time the Army equipped a number of Springfield rifles with silencers, for the use of snipers, but the occurrence of this bullet noise nullified the effect and they were discarded.

The silencer-equipped .22 caliber rifle is very silent indeed, unless high speed ammunition is used; but as most .22 caliber ammunition on sale today is of the high speed variety, the use of a silencer on the .22 is likely to suffer in effectiveness accordingly.

This matter of the bullet noise, which is hidden by the ordinary report, explains one marked difference in the character of the reports of different kinds of weapons. The shotgun, the revolver, or the rifle which shoots low velocity ammunition, all have a rather dull report, which lacks the ringing quality of the report of the high powered rifle, and this is because there is no bullet noise to mix in with the gun report, and add to it. This difference is sometimes particularly noticeable when a ready comparison is available, such as when two small-bore teams are firing over the same range; one using ordinary low speed ammunition, the other the high speed cartridges. The high speed report is much sharper, and is more prolonged, as it seems to come from down the range as well as from the gun; and indeed it does so to a considerable extent, as the bullet noise from the targets and from objects along the sides of the range add themselves to the first report. Sometimes, when the ammunition being used has a muzzle velocity just about the velocity of sound, some bullets may travel at a velocity a bit slower than that of sound, while others may go a trifle faster, as there is always a variation of a few feet per second between individual cartridges in the same lot. In such a case, some cartridges will have a dull report, while others from the same box, fired in the same gun, will give the sharp ringing sound described above. The author has seen rifle team members who wanted to discard a lot of ammunition on this account, as they noticed a marked difference in the sound of report, without knowing the cause. Of course, the reader will see that the reason for such a condition was that the shots which gave the sharp sound were just above the velocity of sound, while those that did not were just below that figure; the total difference might have been only a few feet, and well within the tolerance of velocity allowed in ammunition manufacture.

Noises of the Ricochet

When a bullet is fired so that it strikes the water, the ground, a tree, or some other such object at an angle, it is likely to glance off or ricochet, and travel on a long distance further. In this process of striking some object and glancing off, the bullet is usually set to tumbling rapidly end over end; this causes it to make a prolonged, wailing whine, which has a most formidable and dangerous sound. It is a peculiar fact, of which those who may have to do with firearms cases in court should have cognizance, that this sound invariably impresses the hearer as being very close at hand. For this latter reason, persons of education and sound judgment will testify that such a bullet passed within a few feet of them, when in fact it may have gone in some totally different direction, and indeed may never have come within several hundred yards of where they were standing.

The author has seen this latter fact demonstrated in a great number of instances. At one time, for example, he used to shoot against the high bank of an arroyo in Texas, and when the bullets bounced, they usually glanced into a body of water which lay further up the arroyo to the right; and in any event, the shape of the bluff was such that they had to go to the right, and by no chance could they reach the road which lay beyond and to the left of the bluff. Several times, when a shot had been fired and seen to ricochet into the water, someone who had been on the road would remark that the bullet seemed to pass right by his head; whereas it had actually gone at an angle of 45 degrees from his position and at no time had traveled within a quarter of a mile of him. Again, instances occurred there when persons in two different directions from the shooter both said that the same ricochet passed closely by, which was a manifest impossibility.

For the reasons given above, any testimony that a bullet passed close to the witness, which is based on its sound alone, is of very doubtful value.

Identification By Report of Gun

There exists a pronounced difference in the sound of the report given by the various types of firearms, and also in the report of different calibers of the same model of gun. The report of a revolver sounds quite different from the crack of a high-power rifle, and the shotgun gives a still different sounding blast. Furthermore, the report of an arm shooting old fashioned black powder is quite different from that arm when firing the same cartridge loaded with smokeless powder. Also the length of the gun barrel has a great deal to do with the sound of report, even when the same cartridge is used.

It has been a favourite theme of detective fiction of the past to build up part of the plot around this well known fact, and have the villain tripped up by some local expert of acute hearing (and far more acute imagination, if the truth must be known), who would always prove to the apparent satisfaction of the jury his ability to determine exactly what caliber or type of weapon was fired, by hearing its report. It is unfortunate that this timeworn theory must be exploded, but the fact is that such testimony is mostly bunk.

The exact definition, by an individual, of the sound of any firearm discharge, depends upon many factors besides the report of the gun: wind, weather, echo, direction of sound from hearer, direction in which gun muzzle was pointed, angle of elevation of barrel, height of barrel from ground, type of ground and surroundings, and the degree of attention and hearing ability of the individual. The most important factor will undoubtedly be the immediate surroundings of the location where the shot is fired; a shot fired from atop a bare hill sounds entirely different from the same shot discharged across a body of water where the shoreline is heavily wooded. Anyone who has been present on a military rifle range knows that the discharge of a rifle fired from the prone position can often be told from one fired standing. So much for the acoustical properties of a gunshot.

From an exact ballistic standpoint, the report of any gun can be varied by the type of powder or ammunition used, or by the age and condition of the ammunition when it is fired. As we have said before, black powder sounds entirely different from smokeless, and an acute and qualified observer might notice a difference occasionally in various types of smokeless powders. A freshly loaded cartridge, having the proper "ballistic balance" between all its components, will sound entirely different from the same cartridge aged five or ten years when its powder may have dried out a bit and the primer become stale with age. The fresher ammunition will give a sharp, sudden crack from its fully developed and applied pressures whereas the stale ammunition may give a softer and more prolonged sort of boom, from only partially built-up pressure or delayed ignition. Shotshells are more susceptible to slight deterioration than are metallic cartridges.

Hence the Firearms Expert should be reluctant either to give or accept testimony of this nature unless he positively knows that the facts are as stated. The witness who testifies glibly that he "knows it was a number 16 and not a number 12 gun because it sounded just like a 16" had better be taken out and put over the hurdles before his testimony is entered as evidence. It takes the most positive knowledge of both applied ballistics and actual facts to back up an assertion of this nature.

However, it IS possible for an attentive person, within good hearing distance, knowing for a fact that two shooters are armed with certain type or caliber firearms, to differentiate between their reports. For instance, it is easy to tell the report of a .30 Springfield from that of a .25/20 high-velocity rifle, although both give the same sort of sharp crack; or a .22 rifle from a .22 revolver, or a shotgun report from that of a rifle; *knowing that the guns in question are being fired.* To go further than this, is treading on dangerous ground. Any qualified person can determine a great deal from any gun report he may actually hear, but determining about it from someone else's description is apt to be at the best, nothing but a poor guess.

Unusual or Misleading Circumstances

The wide awake investigator will be constantly on the alert for unusual weapons or circumstances, and will not always expect to see only what he has seen before, or has heard described, for there is no end to the number of different combinations with which a firearms crime may be committed While the occurrence of something that is decidedly out of the ordinary may at first thought seem to make the problem harder, it does not necessarily do so, and in fact, most times, quite the reverse is true, for it narrows the field of search to the few persons who are in a position to employ these unusual methods, instead of leaving it open to the thousands who may have only had an opportunity to use the ordinary revolver, shotgun, or automatic pistol. Moreover, when such an unusual device is found in the possession of a suspect, it gives those who are working on the case quite an important confirmation of their original suspicion. These things are really a deterrent to a solution only when the investigator does not know that such things exist, or is not sufficiently keen to keep the possibility of their use in his mind.

It has already been said that solid balls, buckshot, or slugs, may be used in the shotgun. The reverse of this is also true; that is, shot cartridges may be used in rifles, e.g., the .44-40, and in revolvers, as is described in some detail on pages 209 to 212 of Textbook of Pistols and Revolvers.

When cartridges of the rimless or semi-rim type are found, the natural inference is that they were used in an automatic pistol, but this is by no means certain, for some automatic pistol cartridges may easily be used in revolvers. The Colt and Smith & Wesson .45 caliber Model 1917 revolvers are made specifically to use the .45 Automatic pistol cartridge, which is rimless; and the rimless .380 pistol cartridge can be fired with the greatest of ease in the .38 Special revolver, all that is necessary being to wrap a small piece of copper wire in the groove around the rim of the cartridge to prevent it from going in out of reach of the firing pin. The writer has personally demonstrated this to doubting friends who refused to believe that it could be done. The problem is made even easier when the cartridge is not strictly rimless, but instead is of the semi-rim type, as are the .38 A.C.P., the .32

A.C.P., and the .25 A.C.P., for the presence of the slight rim prevents the cartridge from going all the way into the chamber, and it is not even necessary to use the wire around the rim to fire the .32 A.C.P. cartridge in the average revolver chambered for the .32 S. & W. cartridge, and often they can be fired in the .32-20 rifle or revolver. Moreover, there are certain revolvers made in Europe specifically to take the .32 A. C. P. cartridge or the .25 A.C.P. cartridge. The semi-rim .38 A.C.P. cartridge (.38 Super Automatic), is just slightly too large to chamber easily in the .38 Special revolver, but if the chamber is reamed out slightly it is perfectly possible to fire this cartridge in the revolver; and there is always a possibility of encountering a revolver chambered for this cartridge by some gunsmith on special order. This is not to be construed as recommending this procedure, as the Super. 38 has a higher pressure than is usual in revolvers, but the author has known revolvers to be so chambered, and the possibility of that such a gun may be used in a crime exists. In fact, there is practically no limit to what the experimentally minded gun-crank may produce. Some of the possibilities along this line may be seen by consulting the tables of cartridge and chamber dimensions in Chapter 10 of the Textbook of Pistols and Revolvers.

The procedure described above, of firing automatic pistol cartridges in revolvers may just as easily be reversed, and revolver cartridges may be fired in automatic pistols. Of course the ordinary .22 long rifle cartridge is used in both revolvers, rifles, single shot pistols, and automatics, but we are not referring to them; any revolver cartridge which has a body size that will permit it to have a reasonable fit in the chamber of an automatic pistol may be fired in the automatic by simply filing down the rim of the cartridge until the slide will close. Actual cases in which such a filed down .32 S. & W. revolver cartridge has been used in an automatic pistol in the commission of a crime are on record. Much simpler is the mere firing of cartridges of one caliber in a revolver of another caliber when there is little difference in the size of the cartridge and that of the chamber. The author has seen the .455 Webley cartridge fired in the .45 Colt New Service revolver; the rim was too thin, and there were numerous misfires, but some of the cartridges fired, and it would be quite possible for a murder to be committed with such a combination. An actual case is on record where a policeman was shot and killed by a negro using a .45 S. & W. Revolver loaded with .44 Russian cartridges. Four of these cartridges remained in the gun when it was taken from the murderer, and the fit was so bad that it was difficult to get one to go off without misfiring; but the owner had fired two of them with fatal effect just before. It is quite well known to most revolver cranks that the .32 S. & W. cartridge can be fired quite satisfactorily in the .32-20 rifle or revolver. The cartridge is slightly loose in the chamber, but it fires, and the effect is not very different from what it is in the gun which is chambered especially for it.

There are a number of rifles which use cartridges which may also be used in revolvers, the best known of which are the .44-40, the .38-40, and the .32-20. Obviously when a bullet or cartridge of one of these calibers is found, it may have been fired in either a rifle or a revolver. The author at one time used a small Dreyse automatic rifle made to shoot the .32 automatic pistol cartridge. Attention has already been called to the possible use of revolver or automatic pistol cartridges in adapters allowing their use in rifles, or in the "rifled bullet shell" allowing them to be fired in shotguns.

Handling and Care of Evidence

If the investigator is connected with a regular police force or has legal training, he will not need any advice such as is given here, but if he is a hobbyist or other outside firearms expert, whose usual line of endeavor does not include court work, he should keep in mind the necessity of observing certain rules as to the handling of any arms or other objects that are exhibits in the case.

In the first place, if he is entrusted with the custody of any of the exhibits that may later be introduced as evidence, such as firearms for the purpose of making tests, he should realize that it is absolutely necessary to be able to prove in court when the weapon or cartridge or bullet is produced, that it is actually the same one that it is supposed to be, and that there can have been no substitution or alteration.

With guns, this point is very well taken care of by a record, properly witnessed, of the make, caliber, and serial number. Many careful investigators make it a practice to photograph the arm as soon as received, together with a descriptive tag giving the pertinent facts; e.g. "Piper case. Colt's Official Police Revolver, Cal. .38 Special, No. 3775." The photograph should preferably be taken so that the number of the gun shows in the picture.

No article that is to be used as evidence may be altered or changed in the slightest way, and if the investigator is entrusted with the custody of any such object he must be careful to scrupulously observe this rule. This does not prevent him from properly marking the articles for identification, provided that the marking is done in such a manner and location that it will not change or obscure any other marks which may be important in the testimony; such as the markings on the head of the fired cartridge case, or the rifling or other marks on the side of a fired bullet, which may be essential to establish the fact that the cartridge or bullet was or was not fired from a certain gun.

Thus, the cartridge case may be marked neatly on the inside of the mouth, and the bullet on its base; it would be inexcusable to mark the bullet on its side, where the rifling marks are located, or the fired case on its head. Many coroner's physicians and others who may have the care or handling of recovered bullets have not yet learned the importance of this point, and the work of the identification expert has often been handicapped by having a large and rough X or other mark carelessly scratched upon the side of the evidence bullet by such an indifferent or ignorant official. The recovered bullet should be handled with the greatest care, and not be thrown into or carried with hard objects which may scratch or dent its surface.

It is the usual custom, when articles constituting legal evidence in a case, are passed from one person to another for any purpose, to note such transfer and make it of record by means of a signed receipt: and when the investigator receives any such object, he will be expected to receipt for it. In a like manner, when he relinquishes control of it, he should be equally careful to take a receipt for it.

CHAPTER 8

ADVANCED FIREARMS IDENTIFICATION

THE advanced firearms identification expert who intends to appear in court as such should be not only a thoroughly practical expert on firearms, but in addition, he should be a trained microscopist and he should either himself be a first class photographer, or else he should have the services of one always available. In addition to all this, he must have a good "court presence;" that is, he must be able to get up before a jury and talk to them clearly and with authority. His education and command of the English language should be such as to inspire his hearers with a feeling that he is a man of learning, and his knowledge of the subject must be so profound that there is no chance for any one to shake his testimony in any way or to confuse him in the least.

In the last chapter it has been shown that almost anyone who makes the subject of firearms and their ammunition his hobby, and studies it enough to be thoroughly familiar with the different guns and how they work, can often be of very great assistance to the legal authorities in the preliminary phases of an investigation involving firearms. Indeed, there are several men possessing precisely this grade of firearms knowledge and experience who have in the past made the profession of Expert Witness on Firearms their principal means of livelihood.

Many of these men have given quite a large amount of time and thought to the problem of determining whether a fatal bullet or cartridge case did or did not come from a given gun.

To any one who is acquainted with the present science of Firearms Identification, many of the ideas that have been tried out with greater or less success in the past will seem crude indeed. For example, one plan that has been used to a certain extent, and which is described in some texts on the subject, (e.g., Expertise en Armes à Feu, by Derome), is to roll the fatal bullet and the test bullet on carbon paper so as to make on the white paper under the carbon a strip impression of the entire surface of each bullet. Again, a method which has had some vogue abroad is to make impressions of the circumferences of the two bullets on strips of tinfoil. Anyone who has done any amount of work with the comparison microscope, and knows from experience what a wealth of fine detail can be brought out by the proper illumination and microscopic examination of the specimen will realize the comparative futility of the methods just described.

Another method, which has distinct possibilities, is to make an enlarged photograph of each bullet on a long strip of film, having the bullet rotate in front of the camera in synchronization with the film, which moves inside the camera, so that the whole circumference of the bullet is shown on one photograph.

All these methods have now given way before a rather standardized technique that was developed by a group of scientists who took the problem in hand, as has been described in the first chapter. Fortunately, several makers of microscopes and other high grade optical instruments have placed on the market a line of specialized instruments designed solely for the work of bullet identification, the most important one of which is the Comparison Microscope and its Camera. The Spencer Lens Company of Buffalo, New York, has kept closely in touch with Col. Goddard and other scientists who specialize in Firearms Identification, and have produced precisely the instruments that these scientists have determined to be necessary. This company publishes an illustrated catalog of Comparison microscopes and other instruments for firearms work, which everyone interested in this work should be familiar with. In America, the Bausch & Lomb Optical Co., of Rochester, N. Y., and in Europe, Ernst Leitz, of Wetzlar, Germany, also makes comparison microscopes especially fitted for bullet and cartridge work.

KNOWLEDGE AND EXPERIENCE REQUIRED TO BECOME AN ADVANCED EXPERT

To become preeminently successful in preliminary firearms investigation, the worker requires that very extensive and thorough knowledge of firearms and their ammunition that ordinarily is acquired only by having that subject as a hobby, and by taking such a keen interest in it and everything connected with it that the pursuit of firearms knowledge becomes one of the chief pleasures of life. But even the possession of this knowledge and experience does not fit one to enter the field of advanced firearms investigation, for the understanding of scientific instruments and how to use them is highly necessary also. Unless the aspiring expert has an experimental turn of mind, with a liking for scientific instruments and a knack of using them correctly, he is not likely to make an outstanding success at advanced firearms identification.

This does not mean that he must be a scientist, or that he must possess a scientific degree from some institution of learning, or even that he must be a college man; several of our most successful experts never saw the inside of a college or university. Of course, a college education helps; but it in itself is not the slightest guarantee of success in advanced firearms identification work. Too often the scientist, who has been theorizing around some University or College laboratory for years, does little, if any better than the self trained man with a lot of practical knowledge; he may be so wrapped up in his scientific work that he is narrow and opinionated, and no matter how well he may know his microscopes and test tubes, he is likely to make a sorry spectacle in court unless he knows enough about firearms in general to avoid the very real danger of having a smart practical man on the opposing side make a monkey of him, as has happened in certain cases known to the author. Imagine, for example the feelings of the very learned gentleman who testified that the bullet submitted to him came from the suspected gun and could have come from no other, and showed photographs to prove it, only to have the very practical expert for the defense show beyond the slightest doubt that the murder bullet could not have come from the gun in question, and moreover, did not resemble either bullet in the expert's comparison pictures. The two bullets that the expert had examined and photographed did match, to be sure. but *neither of them was the murder bullet!* This man had handled his scientific instruments perfectly, but had neglected the rather important item of being sure that the bullet he was comparing was actually the fatal bullet, and was working with two test bullets both fired for recovery from the suspected gun.

What has been said must not be construed as meaning that a scientific education is a handicap, for quite the reverse is true, and the trained man with a scientific education and a liking for firearms has the best chance in this work, and succeeds the most easily; but the intelligent man can also succeed in this work without any such education. If the well educated man who intends to go in for this work has a taste for it, he will have a natural interest in firearms; and if he is wide awake, he can, by a little application, soon learn all that he needs to know about how they work; in the meantime, he will realize his lack of practical experience along this line, and until the arrival of the time when he has acquired this experience, he will associate himself with some man who knows firearms and shooting from the practical side.

It is a good thing for anyone who is intending to go in for this work to join any local rifle and pistol clubs, and to actually engage in the matches. In this way, he will learn many useful things about all kinds of guns, and he will acquire a host of friends who are well informed about guns and shooting, and who will be only too glad to help him out with reliable information, often just when it is most needed.

The author has no patience with the attitude of some of the practitioners of advanced Firearms Identification, who try to make everyone believe that only the chosen few can ever hope to succeed in this work, on account of its supposed great abstruseness and difficulty. Of course it is very much harder and more complicated that most people think it is; but any good smart man can learn it if only he is somewhat mechanically inclined, and has a liking for experimental work and for scientific instruments. Every large police force has one or more clever men who are perfectly capable of more or less success in this work, and even if they do not at first succeed in every case, skill will come with experience. As an example, some six years ago a detective sergeant on the Metropolitan Police of the District of Columbia came to the author's office and asked for information about bullet identification. He was furnished with a number of pamphlets and articles on this subject, and was referred to Dr. Souder, and to Col. Goddard. After some assistance and instruction from Dr. Souder, he went out to Chicago and studied this work under Goddard, and today is well known in this field. This man is Lieutenant John H. Fowler, of the Metropolitan Police of Washington, and the author can say, from personal contact with his work, that he is excellent on both bullet and cartridge comparison under the microscope, and on bullet and cartridge photography. Such a man is invaluable to any large police force, and every city should have some one of this type in its police organization.

One of the chief difficulties of bursting at once into full flower as a Firearms Identification Expert is the fact that a certain amount of reputation is necessary for the expert before his services will be in demand; and moreover, unless he can show very conclusively that he is fully qualified, he will not be admitted to the court as an expert. Previous experience in this line is extremely valuable as proving qualification.

Cartridge Collection and Ballistic Records

Another difficulty is the fact that besides the expensive instruments required, the expert should have at hand a number of samples, and much recorded information on arms, and both of these are hard to accumulate suddenly. The recorded information should include such things as the caliber, number of lands and grooves, direction of rifling, etc., for as many different kinds and makes of guns as possible; the weight in grains of each make of each caliber of bullet; and as much data of all kinds on all arms, either current or obsolete models, as can be obtained. As was mentioned before, Lieut. Fowler's card index of bullet weights alone contains over 3200 cards; but when he is confronted with a certain caliber of bullet of a certain weight, he already has a long start toward knowing just what it is.

Besides this written information, it is most useful, and in fact, it may be said that it is necessary, to have samples of every different caliber and type of cartridge made by each of the cartridge companies, and especially, two or more fired cartridge cases and sample bullets which have actually been fired and recovered, for each caliber and make of weapon that it is possible to get them for. As an example of what the leading men in this line have in the way of recovered fired cartridges and bullets, it may be stated that several years ago at Col. Goddard's request, the author furnished him with sample fired bullets and cartridges for his collection from the .45 Savage Automatic Pistol. Most people do not even know that such a gun exists, as only a very few were ever made; but the author happens to have one of these few sample guns, and there is always a possibility that one of them may be involved in a case requiring identification. Another thing that should be had is a sample of each of the more common pistols and revolvers, and also of as many as possible of all the other kinds. It is particularly useful to have on hand samples of the older guns, now obsolete, such as the Forehand & Wadsworth, the Hopkins and Allen, and others, as these old guns, that have been lying forgotten in some bureau drawer, very frequently figure in shooting cases. The Police Department Expert should constantly keep in touch with the matter of the confiscated arms that are on hand in the department, and any that might be useful from this angle should be placed in the Department Laboratory for reference purposes.

This collection should not be limited to one sample of each gun represented, but instead, there should be two or more examples of each kind; and the collection of fired cartridges and recovered bullets, should include several from each individual gun, all individually marked and identified with the make, type, and serial number of the gun from which they were fired. There is a very important reason for this duplication of samples. This is the fact that it is vitally important for the operative to become thoroughly familiar with the variations between individual guns of the same kind, and especially with the differences in appearance of test bullets fired from different guns of exactly similar type, as well as with the similarities and differences in bullets actually fired from the same individual gun. One who has never had much experience in this work might very well mistake unimportant accidental similarities in two bullets for an indication of identity. A considerable amount of actual work along this line is necessary to gain first hand knowledge of the similarities that may be found in two bullets fired in different guns, as well as with the differences to be expected in bullets from the same gun.

Problems Arising and Methods of Procedure

Problems in firearms identification generally arise from the finding of one or more bullets or cartridge cases at the scene of the crime. Sometimes the suspected weapon is available, and other times there is no other information as to the weapon used except the knowledge that it must be one that could have fired the bullet or used the cartridge in question.

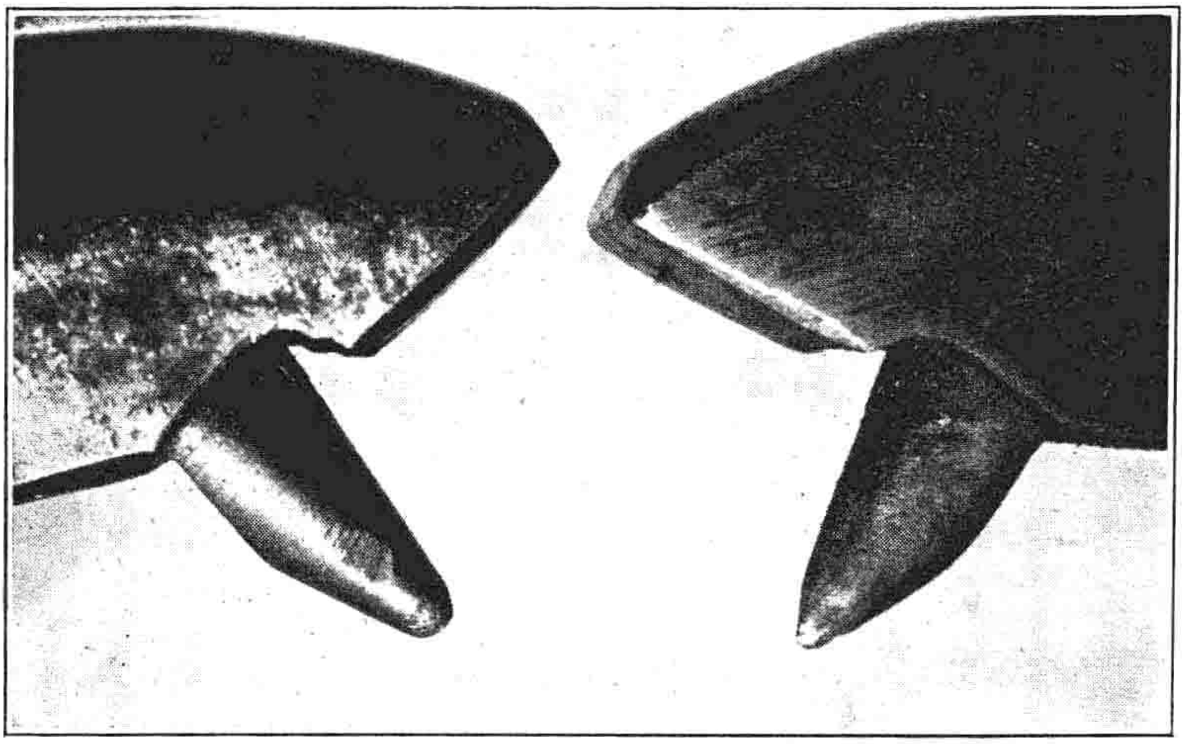
Thus there are two general classes of problems. In the first class the fatal bullet or the empty cartridge case is available and it is desired to know from examination of one or both what kind of gun was probably used in the crime. Frequently the information thus gained directs the further efforts of the investigators.

In the second class of problems, the fatal bullet or the cartridge, or both, are on hand together with a suspected gun. The problem now becomes that of determining definitely whether the bullet or the cartridge in question was or was not used in the suspected weapon.

In considering the methods to be used in solving such cases, it is well to bear in mind the fact that when a gun is fired it leaves on both the bullet and the cartridge case certain marks which may be divided into three categories.

First, there are the class characteristics or marks which *all* guns of a given type will leave. For example, *all* rifled arms will leave grooves on the bullet. *All* Colt guns will leave left-hand rifling on the bullet. Most automatic pistols will leave extractor or ejector marks, or both, on the cartridge case.

An example of class characteristics are the little crescent shaped mark left on the head of the cartridge, and the circular tool mark impressions left on the primer by the Thompson Submachine gun. The crescent shaped mark on the top edge of the cartridge head is the dent made by the bottom edge of the circular bolt in driving the cartridge out of the magazine. The circular lines left impressed on the primer are caused by the fact that the bolt face is circular, and is finished by machine, so that circular tool-marks surround the firing pin hole, instead of vertical marks, as on the automatic pistol, or horizontal marks, as on most revolvers.



Firing pins, even on similar guns are often quite different in shape as is clearly shown in this photograph by Captain E. C. Crossman. Such differences form excellent negative proof, for obviously a cartridge fired by either of these guns can be shown to have such an appearance that it could not have come from the other gun. Evidence of this kind is often extremely useful in establishing innocence, or in eliminating suspected weapons.

The second category is what may be called individual characteristics. If a particular gun had a broken firing pin nose it would leave a certain mark on the primer that no other gun would leave; it is an individual characteristic of this particular gun and no other gun. In the same way, if a gun has certain irregularities in the surface of the bore, it will leave peculiar grooves on the bullet which would be made by no other guns. Individual characteristics of this kind do not determine the type of gun which was used, but the actual individual gun.

Rifling Marks on Bullet

The most important individual characteristics which are used in firearms identification are the fine ridges and grooves on the surface of the bullet, parallel to the rifling marks, and the fine ridges and grooves impressed into the soft metal of the primer or the head of the cartridge case.

The identifying marks on the bullet are caused by its passage over surface irregularities and rough spots on the interior of the gun barrel that got there principally during the machining operations of reaming the bore and rifling the grooves. Any such machining operation will leave the bore at least slightly rough, and each rough spot will leave a mark on the bullet during its passage through the bore. If there should be some pronounced defect in a tool, such as a nick in the edge of a rifling cutter, it may leave a very noticeable mark which is likely to be repeated in several grooves of the same gun, or even in several different guns made at the same time; but the general pattern of microscopic irregularities is caused by the way in which the chip which is removed in machining separates from the remainder of the metal when it is torn off by the cutter as it plows along the surface during the machine operation. It is removed by a sort of lifting and tearing process as the edge of the tool forces itself between the main body of the metal and the smaller portion which is being removed. It will be readily understood that any such tearing action will result in a random pattern of irregularities which is hardly likely to be exactly repeated. Moreover, the chips and small fragments of steel that are removed sometimes become wedged under the edge of the reamer or rifling cutter and thus make irregular scratches, tears, or grooves. When it is considered that every rifle or revolver has at least several different lands and grooves, each of which has a random surface pattern of its own, it will be appreciated how utterly unlikely it is that any two guns will give exactly the same pattern of markings on the bullets fired from one as will be found on those fired from the other, and it will be seen what possibilities this method of bullet identification offers.

It should be understood by the reader that some guns have the barrels smoothed up after machining by a process known as *lapping*. A rod is inserted into the barrel, and a lead plug is cast on the end of this rod, so that it exactly fits the lands and grooves. This lead plug is then covered with oil and emery flour, and passed back and forth through the barrel a number of times, until the most noticeable roughnesses are removed. This operation makes the inside of the barrel much smoother than it would otherwise be, and adds somewhat to the difficulty of bullet identification.

The marks on the primer or cartridge head are caused by the fact that the surface of the breech block, against which the head of the cartridge bears, is always finished either by a cutting tool, or by a file, and either method will leave the surface covered with irregular fine lines. When the explosion takes place, the head of the cartridge is driven back against the breech block with great force, and in many cases the soft metal of the primer, which is either copper or brass, will take a perfect impression of these lines. In other cases, the lines will also be impressed on the brass cartridge head, though the primer takes this impression somewhat more easily, in general, than does the cartridge.

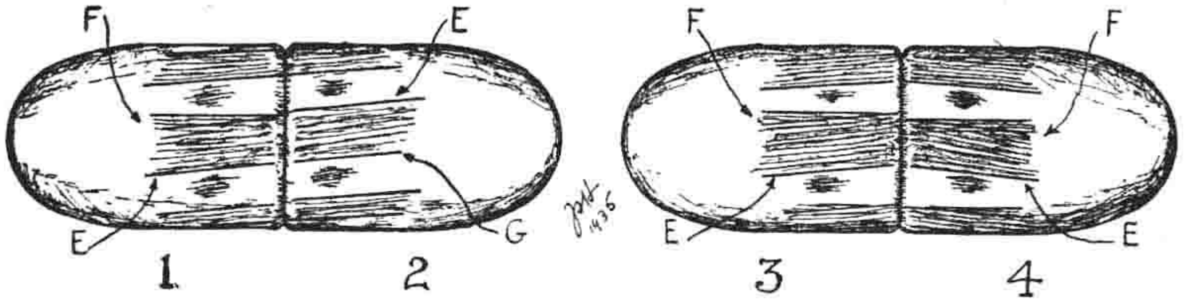
As each breech block has quite an individual pattern, it will be seen that a fired cartridge may often be shown to have come from a particular individual gun by comparing it with a test cartridge fired in the same gun.

In addition, there is a third category of markings known as accidental characteristics. These are characteristics or marks left by some individual gun that occurred on that particular shot and may or may not be reproduced on any other shots. If, for example, a grain of sand or shaving of steel happened to be in the barrel when a shot is fired, a mark might be left on that particular bullet but on the next shot the piece of steel or grain of sand might not be present and there would be no mark. In general these accidental marks are of little or no help in solving cases.

Given a Bullet, What Kind of Gun Was Used?

The most frequent situation confronting a firearms identification expert is to be given a fatal bullet which was recovered from the body of the victim with a request for information as to what kind of gun was used.

In this case we are obviously concerned with class characteristics relating to caliber, rifling, etc. It is usually possible at once to say what caliber of gun was used, and it is also obviously quite easy to tell several different calibers and kinds of guns that the bullet did not come from, but even with full data such as is possessed by the Crime Detection Laboratory of Northwestern University, it is difficult to say with certainty the exact make of gun that was used.



A ROUGH METHOD OF BULLET COMPARISON

A quick idea as to whether a given bullet might or might not have come from a certain type of gun may often be obtained by placing the bullet base to base with known samples, as shown in the sketch. 1 is the fatal bullet, and 2 is a sample fired from a .45 automatic pistol. While there is a difference in the width of the marks left by the lands on the two bullets, the conclusion is that the murder bullet could have come from either a .45 automatic or a .45 M 1917 Colt revolver, which has the same rifling dimensions as the automatic. (The two samples used as models for the sketch had actually been fired in two different .45 automatics. There is an unusually large difference in the groove width in these two guns). 3 is the same fatal bullet placed base to base with a bullet fired from a .45 S. & W. Model 1917 revolver. It will at once be seen that the two bullets came from different guns, as the direction of the twist is different. This rough method is of use chiefly for a comparison of such easily apparent things as the number of grooves, twist of rifling, etc.

E, E, E, E are the driven edges of the marks left by the lands.

F, F, F, are the trailing edges of the marks left by the lands, showing "skid marks" caused by the bullet's plowing straight into the rifling for a short distance before it takes up the motion of rotation.

G is a trailing edge which does not show skid marks.

The difficulty of the task often depends a great deal on the circumstances of the crime. The recovered bullet may be almost intact and in its original shape, if it happened to penetrate flesh only, or it may be badly deformed if it happened to have struck bone or other hard substances. Moreover, it may be mutilated by rough handling with a surgeon's forceps. Nevertheless it is usually possible to tell a great deal from a recovered bullet, if the proper instruments are on hand and the bullet is subjected to the proper kind of examination.

Naturally we are interested primarily in the caliber. We want to know whether or not the bullet came from a .32, a .38 or from some other caliber, and this can usually be determined by observation and comparison with known samples, or, if necessary, by measuring the bullet diameter. Even though the bullet is smashed at the point, the base is usually intact and an accurate measurement of the diameter can generally be obtained. For this purpose measurements across several diameters should be taken and averaged. This data taken in conjunction with the weight, (and it may be stated here that a bullet usually changes very little in weight even though it is badly deformed), will give a very strong clue as to the caliber of the gun.

Moreover, the caliber and the weight, taken together, may go a long way toward telling the make of bullet we are dealing with, for many makers vary somewhat from the standard weight from bullets of certain calibers. Thus, one maker may use a 100 grain bullet for his .32-20, and another may use 115 grains. A comparison of the recovered bullet with the samples furnished by all the various makers will also often help to identify the bullet as to make and type.

Having learned the caliber, which is fairly easy, we will then want to try, if possible, the very much more difficult task of determining just exactly what make and type of gun of this caliber was involved. We already have (a) the weight of the bullet, (b) the diameter of the bore; the other class characteristics necessary for a complete identification of the type of weapon used are (c) the direction of rifling, (d) pitch of rifling in turns per inch, (e) number of grooves, (f) width of lands, (g) width of grooves, and (h) depth of grooves.

The first thing to determine is the number of grooves left on the bullet by the rifling, for there is quite a variation between the different makers in this respect, and this information will eliminate about half the makes of gun at once. For use with this information, the expert needs a tabulation of the characteristics of all makes of gun, and he should obtain or compile as nearly complete a tabulation of this kind as is possible. Much information on this point is given elsewhere in this book, and particularly in the tabulation at the end of this part.

The next thing to obtain is the direction of the twist of the rifling, for this will eliminate another section of our possibilities; this is because the Colt guns have left hand rifling, while all other American, and most European guns have right hand rifling.

Theoretically, the next thing to do is to read the width of the land and groove marks with a filar micrometer eye-piece or a measuring microscope, and obtain the pitch of the rifling in turns per inch, and compare these data with the tabulation; but practically this is not very often attempted by the average American worker in this field. In the first place, these readings are difficult to make, especially if the bullet is deformed; and in the second, it is easier and more practical to place the bullet under the comparison microscope together with various sample bullets from the worker's collection, which are known to have been fired from various makes of arms, until one is found that matches exactly as to width and inclination of grooves.

It will be understood, of course, that so far we have been concerned only with identifying the type of gun and not with trying to find out whether or not a bullet came from a particular individual gun. This will come later when the knowledge already gained has enabled the authorities to seize the suspected weapon and submit it for examination.

Determining the Type of Weapon from a Cartridge Case Found at the Scene of the Crime

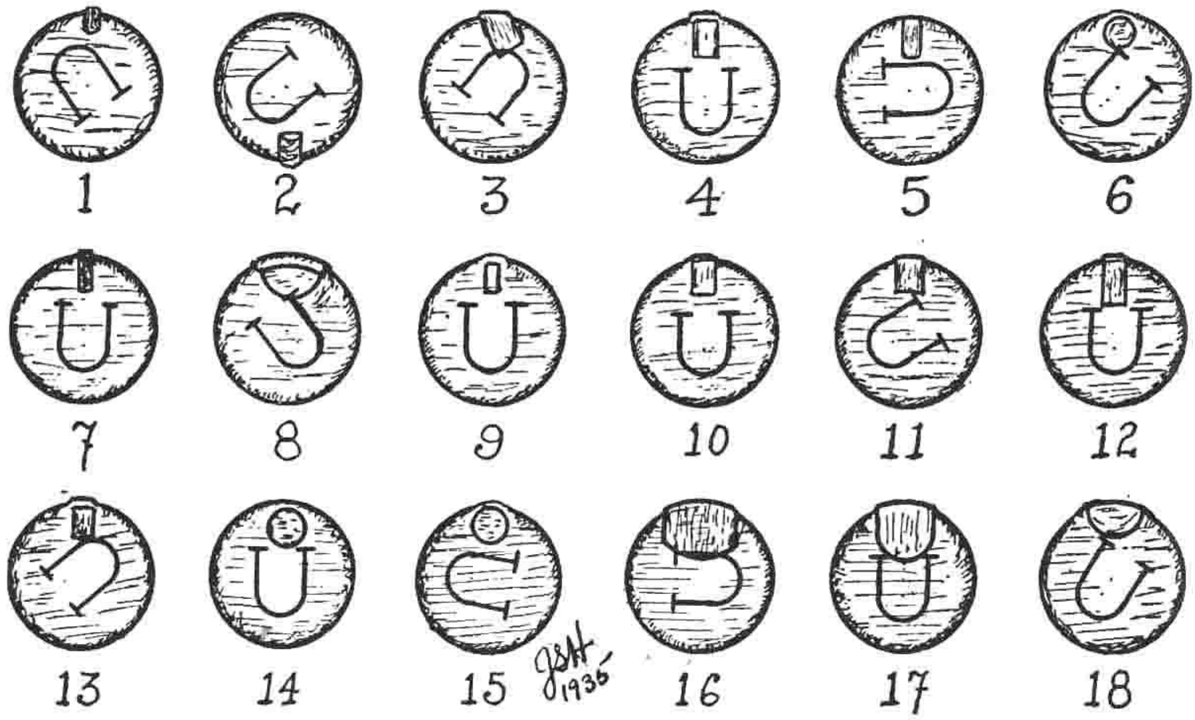
It may frequently happen that in a crime of violence with firearms the bullet may not be recovered; it may pass entirely through the victim and be lost. This brings to our attention the fact that any automatic gun, such as an automatic rifle, pistol, or shotgun, or a machine gun, has one great disadvantage as an instrument of unlawful violence, and that is the fact that each time the gun is fired, it throws out an empty cartridge to remain and tell its tale to the investigators. For this reason, it is common in the case of homicide with any such weapon, for the investigators to find one or more empty cartridge cases, and these cases may often be made to tell far too much of a story for the safety of the criminal.

In many cases, also, the repeating shotgun or rifle may be fired two or more times in the commission of a crime, or if it is fired only once, the chances are that the criminal will reload at once, unconsciously causing the gun to eject the empty cartridge, and leaving it at scene of the shooting. In cases where the revolver is the weapon used, it is much less common to find any cartridge remaining at the scene, for the criminal is unlikely to reload if only one or two shots have been fired, and the empties will remain in the gun, to be removed later.

Like the recovered bullet that we have discussed above, the empty cartridge case has a number of prominent class identification marks, the most obvious of which are the initials of the maker and sometimes the date stamped on the head of the case. Moreover, the type and caliber of the cartridge is usually readily recognized.

Thus the investigator knows at once what caliber of gun was used and the make of the cartridges.

There are, however, a number of much more definite class characteristics which may indicate with certainty the particular type of gun that figured in the case. This is due to the fact that all automatic arms put certain marks on cartridges which are extremely useful in identification.

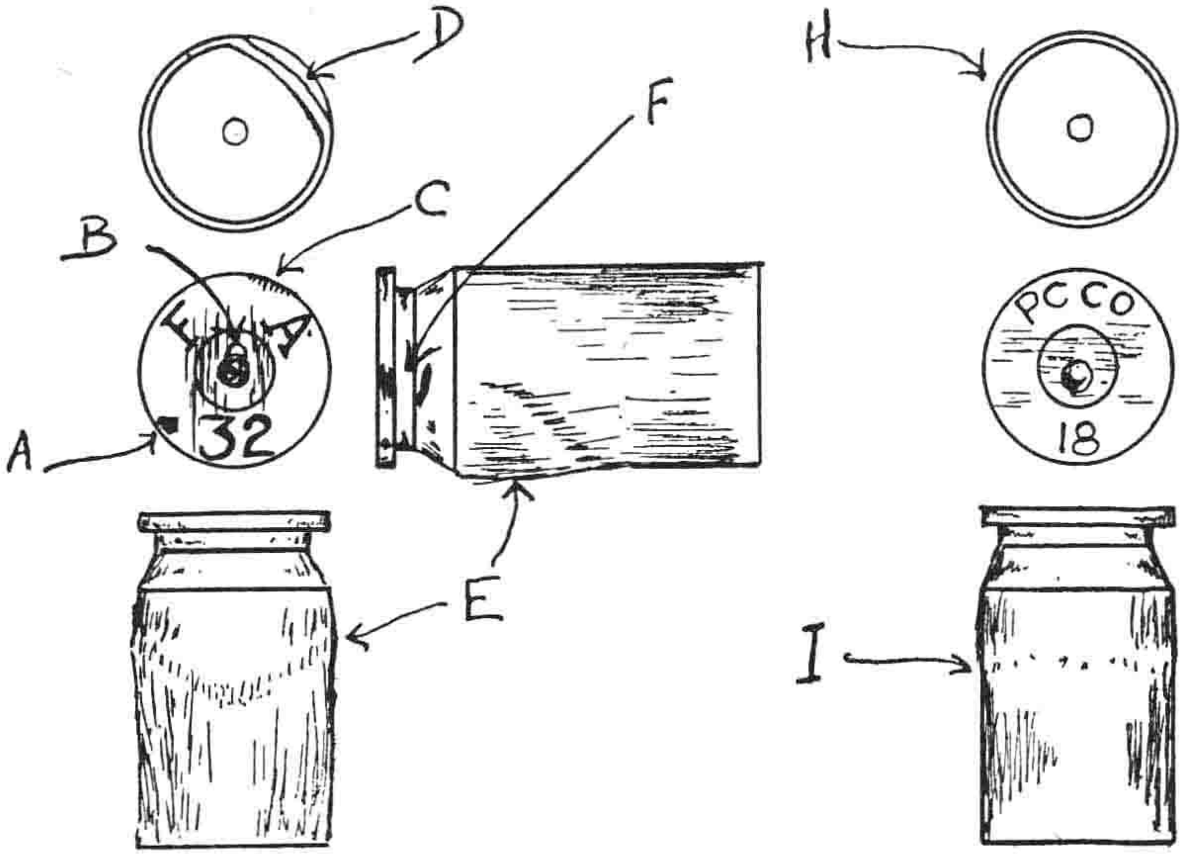


Sketch showing the difference in the firing pin imprints left on rim-fire cartridges by different makes of .22 caliber arms.

1. .22 caliber Remington Autoloading Rifle, similar to model 24A, but a very early sample, given to the author by the late John Browning, the inventor of this gun.
2. Webley single shot target pistol. Note that the firing pin is on the bottom.
3. The Fiala Combination Rifle and Pistol.
4. Colt Woodsman Automatic Pistol.
5. Colt Ace Automatic Pistol.
6. The Reising Automatic Pistol.
7. The Winchester "52" .22 caliber rifle.
8. Iver Johnson Supershot Sealed Eight Revolver, early sample.
9. Same, later sample.
10. Colt Officer's Model Revolver.
11. Colt Banker's Special .22 Revolver.
12. Colt Camp Perry Model Pistol.
13. Harrington & Richardson U. S. R. A. Model Single Shot Pistol.
14. Smith & Wesson Single Shot Pistol, Perfected Model.
15. Smith & Wesson K-.22 Revolver.
16. Savage .22 caliber repeater, old model bought in 1916.
17. Winchester Single Shot .22 Musket.
18. Stevens Conlin Model Target Pistol.

In the first place, most automatic pistols and all machine guns have extractors, and the extractor hook marks the cartridge. Also the shell is ejected by being drawn back violently against a plate of metal known as the ejector, which marks the head of the cartridge with a fixed relation to the position of the extractor mark, though in some pistols the firing pin acts as the ejector, and this mark will be absent.

Then in the automatic pistol or machine gun the cartridges lie in a magazine, and they are pushed up to the top of this magazine by a strong spring so that the top of the cartridge rests against the bottom of the breech block. As the gun is fired the breech block recoils, dragging itself backward over the top cartridge. When the breech block has cleared the cartridge and is out of the way behind it, the cartridge rises to a higher position and is held from



Characteristic appearance and marks found on cartridges fired in automatic pistols and in revolvers. Left, cartridge fired in the .45 caliber Government Model Automatic Pistol. Note the following points. "A", the ejector mark, usually visible to the unaided eye. "B", the secondary firing pin mark, or scrape, often found in automatics, especially the Super .38 and the .45. It is at the top of the regular primer impression. "C", the upper edge, opposite the ejector is often smashed and marked with striations from the tool marks on the breech. It is here that the case pivots as it is thrown out by the ejector. "D", the mouth of the case is usually flattened, from striking against the side of the slide as it is thrown out. "E", the cartridge is bulged on the bottom, as the chamber is tapered to the rear and cut away at the rear end on the bottom to facilitate feeding. "F", the extractor marks. They are usually most prominent on the forward or sloping part of the cannelure, and on the forward part of the rim. Sometimes there is also a mark, as shown, on the edge of the rim where the extractor has ridden over it from behind in taking hold. In addition, there will be vertical striations on the primer, and usually more faintly, on the head of the case.

Right, case from a .45 Model 1917 Revolver. Note, "H", the mouth of the case is perfectly round, unless it has been stepped on, or otherwise abused since firing. "I", the case is slightly bulged toward the rear, but the bulge is even all around, and not more pronounced on the bottom, as it is with the automatic. The firing pin dent is usually off-center, and most likely toward the bottom. The case head and particularly the primer will have horizontal striations or marks received from the filing marks which run across the breech face from side to side.

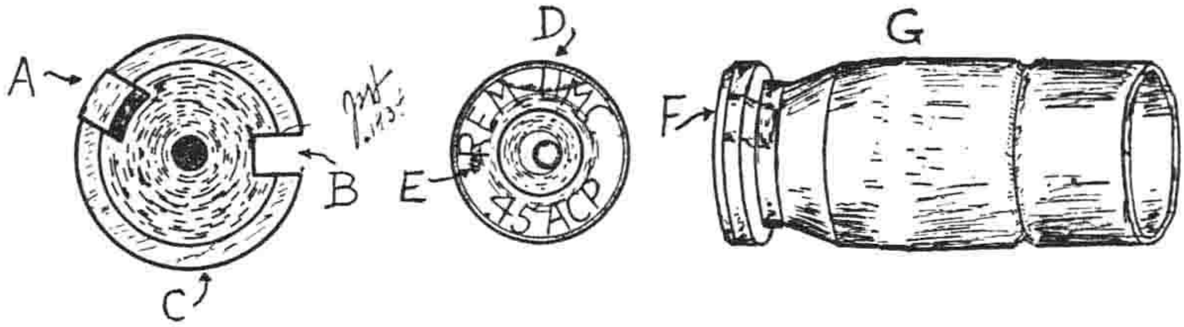
coming all the way out by the sharp steel lips of the magazine. As the breech block then goes forward to reload, it pushes against the top of the rim of the cartridge and forces the cartridge forward out of the magazine and into the chamber of the gun. In sliding forward under the magazine lips the cartridges are frequently scratched in a peculiar way. Then as the gun is fired and the cartridge is ejected, the rim is held by the extractor on the right-hand side while the ejector in effect kicks the left-hand side of the rim forward so that the cartridge pivots around the ejector and the mouth of the empty cartridge usually strikes on the side of the gun and gets a considerable dent.

Thus an ejected automatic pistol cartridge will usually have scratches on top from the breech block, scratches on one or both sides from the lips of the magazine, marks on the front of the rim due to the extractor hook, marks on the back of the head due to the ejector, and a dent on the mouth due to striking the side of the frame in ejection.

It is quite within the realm of possibility that all these marks may not only tell the type of gun that is used but in some cases they may form a pretty certain indication as to the particular individual gun in question. Thus in the *"Scientific American"* for January, 1927, Captain E. C. Crossman states: "Characteristic and repeated scratches on the side of each cartridge tried in a seized gun, formed one link in the evidence which hanged seven Egyptians for the murder of Sir Lee Stack Pasha in Cairo, in 1924."

The cartridges ejected from the Thompson submachine gun have quite a characteristic appearance when they are carefully examined. One mark that is entirely peculiar to this weapon is the mark of the lower segment of the circular breech block on the top of the rear face of the cartridge head. This mark is caused by the fact that the breech block, which is circular in shape, has a fairly long travel to the rear when the gun opens, after which it returns to the closed position under spring action, and in this return motion, it has gathered a considerable amount of speed by the time it strikes the upper rim of the top cartridge in the magazine, to drive this cartridge out of the magazine and into the chamber. This rather violent impact of the lower edge of the bolt with the top of the cartridge head makes a distinct circular mark. Moreover, the ridges left by the irregularities of the breech block on the primer are circular, instead of being across, or up and down, as is the case with revolvers or pistols. In addition, the extractor mark is quite characteristic. The interested student will obtain and study samples of fired cartridges from this gun in comparison with others from the Colt Automatic Pistol and the Model 1917 revolver.

Cartridges from the Browning Automatic rifle, or from the Monitor, which is really the same thing, are readily distinguished from similar cartridges out of the Springfield Rifle or other repeating rifles, by the fact that the firing pin of the Browning is much larger, so that it makes a wide, well rounded mark, instead of the narrow mark left by the firing pin of the ordinary rifle. Also, the ejection of the case makes it strike the edge of the ejection opening, then the side of the gun, and it will have two deep dents on the body of the case, and one on the mouth.



CHARACTERISTIC MARKS LEFT BY THOMPSON SUBMACHINE GUN.
Left. Breech face of Thompson Submachine Gun. Note that this breech face is circular, and is finished by machining, so that the surface is covered by tool marks in the form of concentric circles. A—the extractor, which snaps or springs over the edge of the cartridge rim when the breech slams shut, and in so doing, puts scratches on the rim. B—open space, or clearance cut, for the ejector, which is a rectangular piece fixed into the side of the breech recess. When the breech block flies open after the gun is fired, the empty case is drawn back by the extractor hook until the ejector is reached, when the impact of one side of the cartridge head against the ejector causes the cartridge to pivot around the extractor and be thrown out of the gun. The impact of the cartridge against the ejector makes a bruise on the cartridge head, shown at E in the middle sketch. C—bottom rim of the breech block, which strikes the top edge of the cartridge lying in the magazine and drives it out of the magazine and into the gun chamber when the breech block slams home under spring action during the operation of the gun. The impact of this circular edge with the top of the cartridge head makes a circular mark on the cartridge, as shown at D in the middle sketch.
Middle. Head of cartridge which has been fired in Thompson Submachine gun, showing fine circular marks impressed on the primer and cartridge head by the circular tool marks left on breech face. Ejector bruise E and breech block mark D are also shown.
Right. Side view of cartridge fired in Thompson Submachine Gun, showing extractor marks F, which may be more or less visible, according to circumstances; and uniform circular swelling of case, G, which forms a brightened band, more or less visible, directly around the case, instead of around the bottom only, as in the .45 automatic pistol.

Orienting the Fired Case for Examination

In looking for the class characteristics on any recovered cartridge cases, and particularly in firing test cases for recovery and comparison, it is important to bear in mind the necessity of the proper orientation of the cases for examination. By this is meant the turning of the cases so they all have the same side up, so to speak, or in other words, so that they will have the same relative position that they had in the chamber of the gun. This can often be determined by the extractor or ejector mark, or by some other mark, such as the little crescent left on top of the cartridge case by the bolt on the Thompson submachine gun.

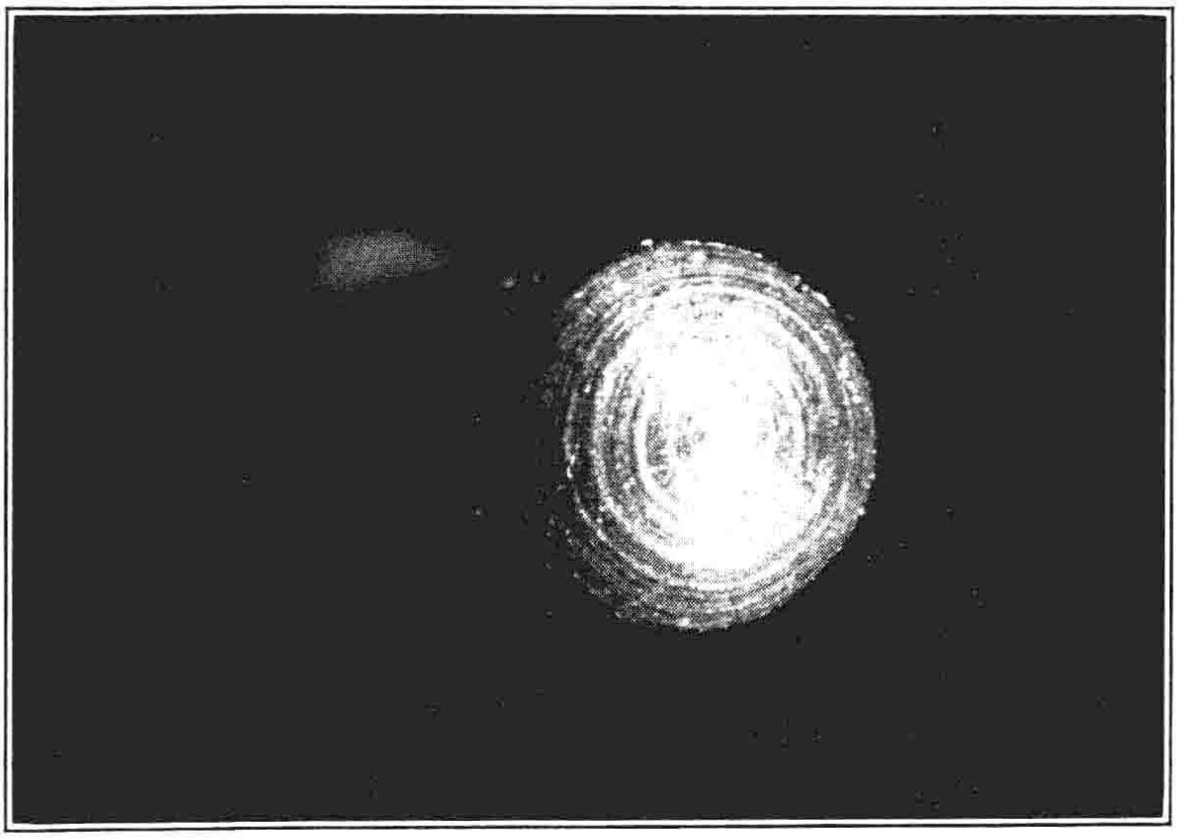
The natural tendency of anyone receiving several cases to compare would be to place them all so that the lettering on the base would be right side up; but it would be obvious to anyone who has given the matter any thought, that the lettering is not what should be used to position the case for this examination, but rather the marks left by the gun. The position of the lettering relative to these marks can be very important, however, for the stamping on the head of the case might cover certain parts of the breech face, and would therefore obscure any impressions that might have been left by this part. For this reason, when a cartridge is fired in a known weapon for comparison with an evidence case, care should be taken to so place it in the chamber of the gun that the lettering will be positioned in identically the same way as that on the evidence case was. The importance of this precaution will be plainly apparent when the time comes to compare the two cases under the microscope; for if this is not done, some very important markings imprinted onto the evidence case by the breech face may not be visible on the test case because the lettering or deep stamping came just in this place.

Supplementary Case Markings

It should be realized that in addition to the markings caused by the actual loading and firing of the weapon, there may in some cases be supplementary markings which are caused by the cartridges having been loaded into the magazine and then removed from it, or having been inserted into the tubular magazine of a repeating arm, and then removed without firing by working them through the action. In addition, there may be certain other puzzling marks put onto the head or some other part of the cartridge by the machinery used in the manufacture. In one instance, the .38 Special cartridge had a short mark just under the edge of the rim. The edge was beveled, or turned over, for perhaps a sixteenth of an inch. This looked like the mark sometimes left by the extractor of an automatic pistol; but the cartridge was of a revolver type, and was believed to have been fired in a Smith & Wesson revolver. When the remainder of the box of ammunition which had contained this cartridge was located, it was found that about one third of the cases had a similar mark, which varied in size and distinctness from a mere trace to a very pronounced bevelling of the under side of the rim.

IDENTIFICATION OF INDIVIDUAL WEAPONS

Where empty cartridges recovered at the scene of the crime are available and it is desired to know whether or not they came from a particular gun in the possession of a suspect, there is another important type of marking which furnishes far more definite identification, when conditions are favorable, than do the marks described above.

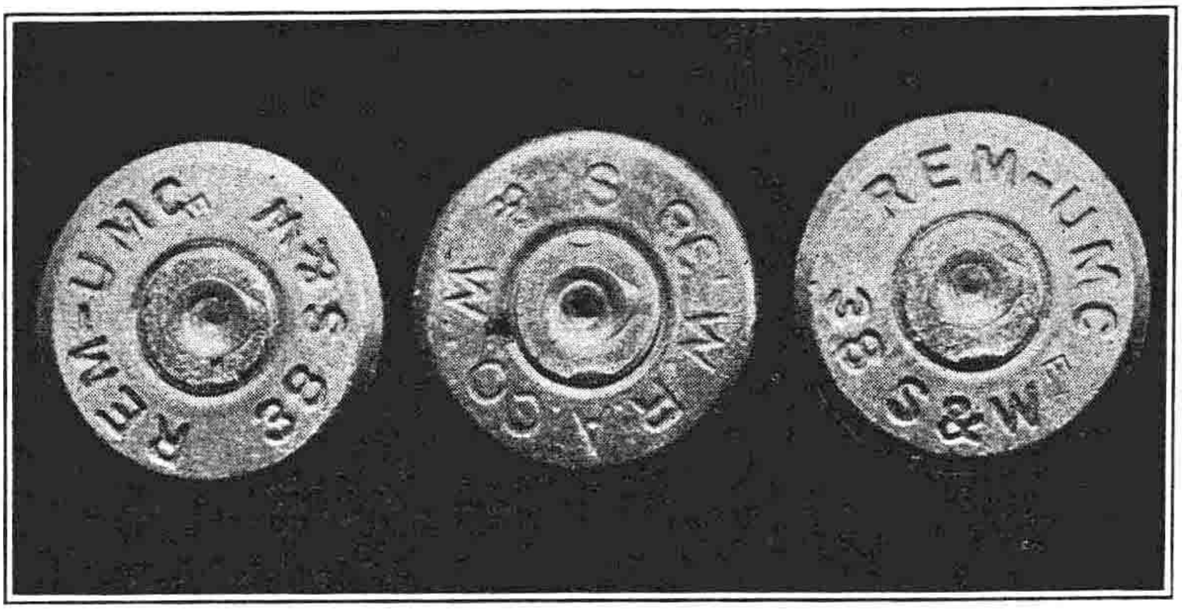


Why a firing pin can sometimes be identified from the marks on the primer. Microphotograph by Capt. E. C. Crossman, of Los Angeles, Calif., showing the tool marks on the end of a firing pin. These same marks are impressed into the soft metal of the primer at the time of the explosion.

These marks are what might very aptly be described as the "finger prints of the firing pin and breech block on the primer." In both automatic pistols and revolvers there are certain fine tool marks or scratches left on the breech face or the metal against which the cartridge presses when it is being fired. These marks are quite pronounced on metal surfaces that have been finished by a file as is commonly done on the breech face of the average automatic pistol or revolver.

Examined under a microscope this surface appears to consist of a number of ridges or scratches, and when the cartridge is fired, the primer, being of copper or brass, which is much softer than the steel of the breech face, will take the impression of these fine ridges.

Moreover, the point of the firing pin will have small ridges, and no two breech faces or firing pin points will be exactly alike. If several cartridges of the same make and time of manufacture as the sample cartridge are fired in the suspected gun and then examined under the comparison microscope, it will be seen that certain identical lines and striations will be visible in each of the sample cases fired in that gun. If these same lines and striations are found in the cartridge case picked up at the scene of the crime, it is highly probable that it was fired in that gun, and if there is a sufficient correspondence in the markings the probability may amount to a certainty.



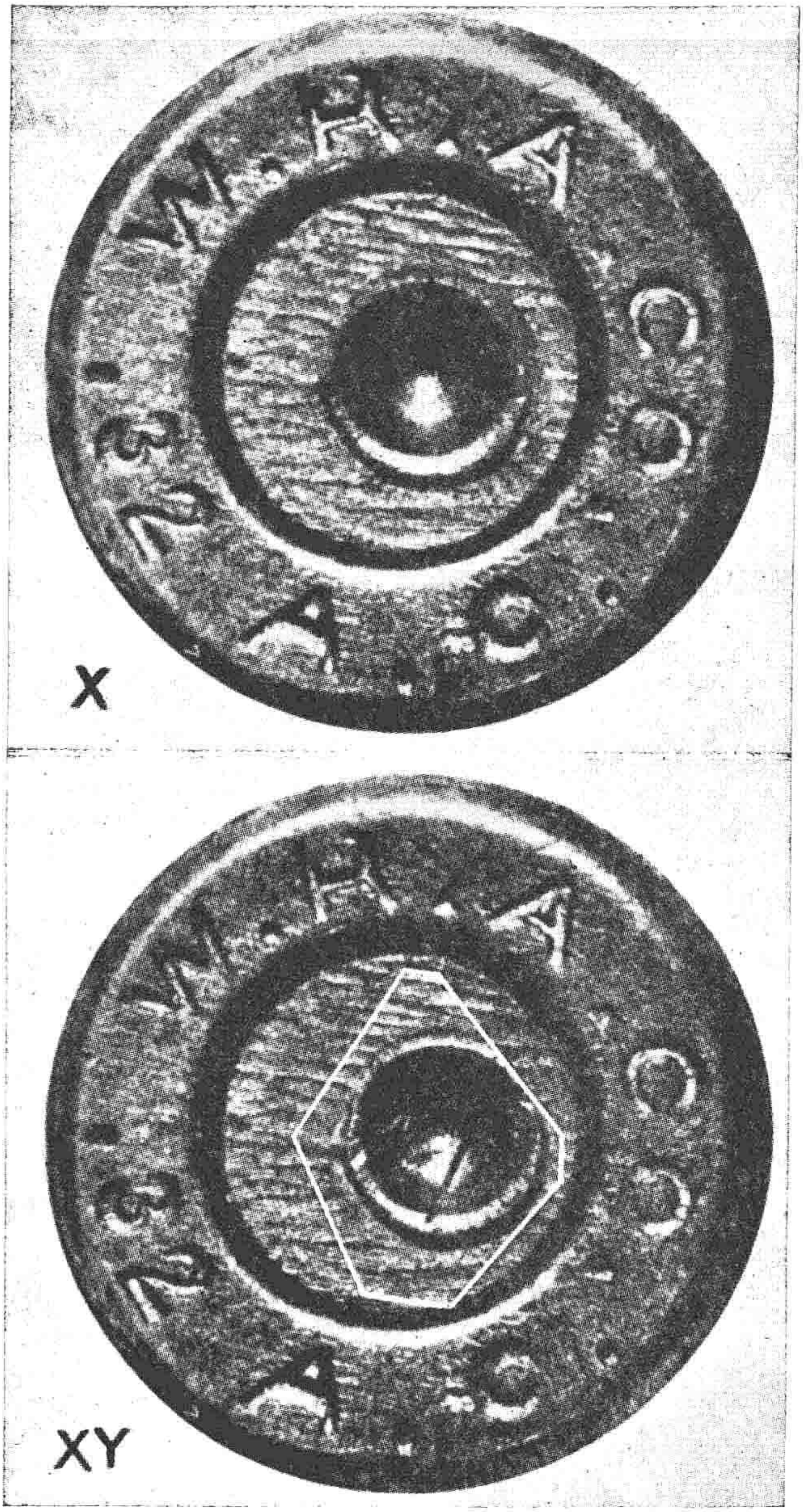
Another case of primer identification by Capt. Crossman. The right and left hand cartridge are the cartridges in evidence in the case, while the center one is a test cartridge fired from the suspected gun. Note the "bracket" extending from the right side of the firing pin impression in each primer. This as due to an eroded edge to the firing pin hole in the breech face of the gun.

Accordingly, when one or more recovered cartridge cases are available, and a weapon is suspected of being connected with the crime, the thing to do is to obtain more cartridges as nearly like the ones found as possible, and fire them in the same gun for comparison with those found at the scene of the crime. The examination is made under the comparison microscope, using the special holders furnished for this purpose, or, in the case of shotgun shells, simply standing them on end on the stages of the microscope. When the man who is not experienced in the use of the microscope first tries to see these marks, he may find absolutely nothing at all, even if the marks are there, because it is quite a trick to adjust the lights and the position of the cartridges so that these marks are most clearly visible. The best procedure is to adjust the microscope lights rather low down, so that the light strikes the surface quite obliquely; then the cartridges are slowly turned, and at one point, the markings will suddenly become visible, because the little ridges and furrows will reach such a position that they will throw shadows in the oblique beam of light. Because the brass is very bright and shiny, it is of advantage to use a blue glass in the light, to reduce the yellow glare of the brass and give it a whiter appearance. Such blue glasses, or a still better kind, called "Daylight Glass" are regularly furnished with the microscope lamps.

When the marks are plainly visible, the two cases are moved until corresponding parts are brought together in the field of view, separated only by the dividing line of the comparison ocular. If such a position can be reached that every irregular line and striation on one case seems to continue on over onto the other, it shows beyond any reasonable doubt that the two cartridges were fired from the same gun.

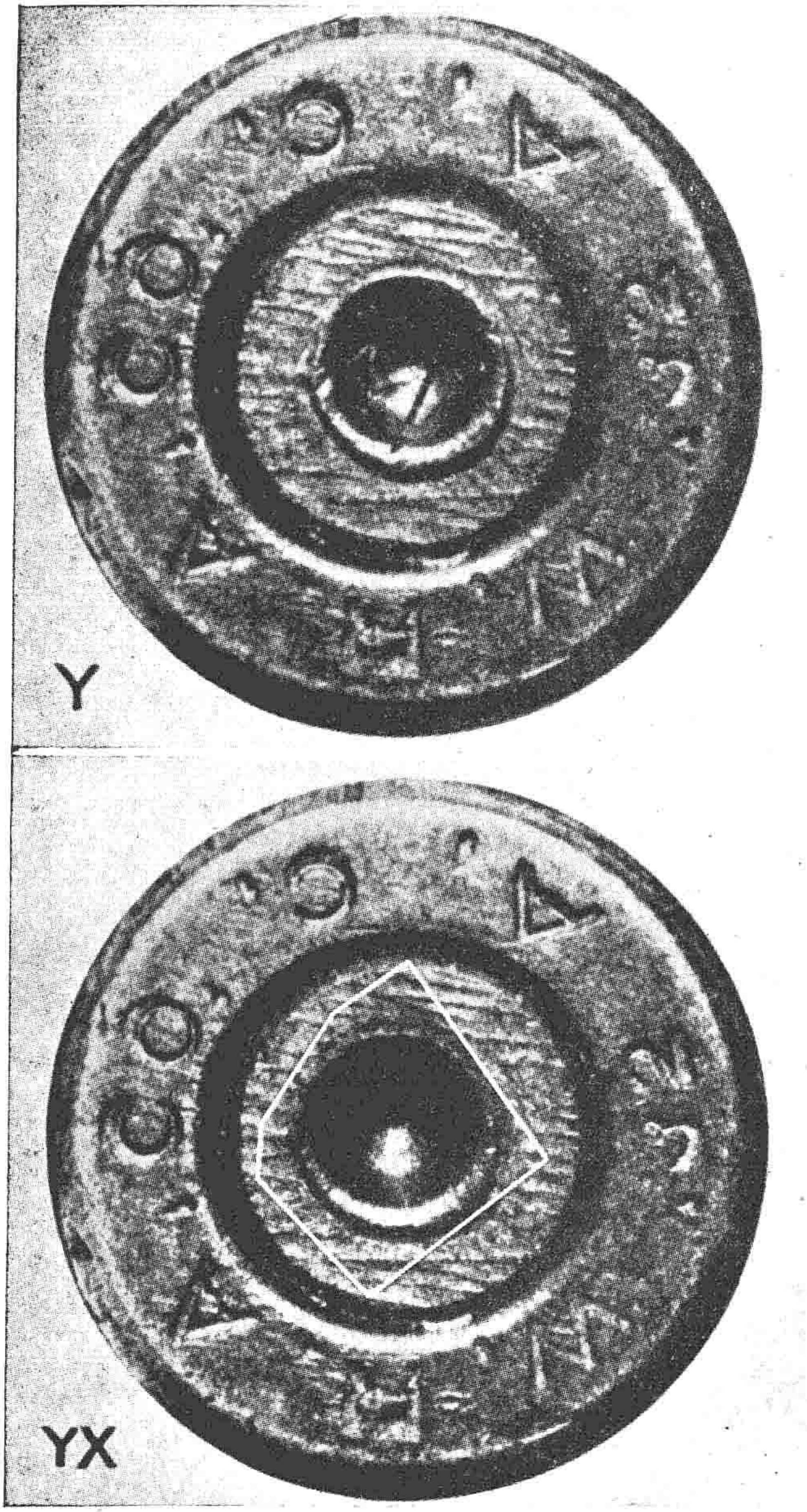
In making identification in this way, it is common to make large photographs of the heads of all the cartridges in question. If a photograph of the fatal cartridge case is cut across at right angles to the ridges left on the surface of the primer by its contact with the breech face, this cut photograph can be laid on photographs of the cartridge cases fired in the gun. If this cut photograph can be matched to one of the photographs in such a way that all the little lines and striations on the cut-out square blend with those on the large photograph, it shows conclusively that the prints were made by the same breech face or the same firing pin. Then again, the firing pin hole is rarely ever exactly in the center, hence the firing pin depression will usually be displaced a little from the center with a fixed relation to the ejector and extractor marks.

Sometimes the face of the breech may receive nicks or dents from the careless use of a cleaning rod, and these irregularities may impress themselves on the head of the cartridge. These facts may aid greatly in guiding the investigators.



"FINGER PRINTS" IN THE HISTORIC SACCO-VANZETTI CASE

The two sets of pictures shown above and on the opposite page illustrate perfectly the method of identifying weapons from the markings left on the primer and the cartridge head by the irregular tool or file marks on the breech face. **X, at the top of the left page, shows a test cartridge in the Sacco-Vanzetti case; Y, at the top of the right page shows the evidence cartridge in this same famous trial. The photographs furnished by Col. Goddard.**



XY at bottom of left page is a duplicate photograph print of Test shell X with an irregular polygonal area from Evidence shell Y superimposed and pasted in place—note the exact matching of markings from the breech face; YX is a duplicate photographic print of evidence shell Y with an irregular polygonal area from Test shell X superimposed and pasted in place—note that markings of breech face match exactly.

Variations in Primer Markings and Appearance

The manner in which the primer sets back and flattens out against the breech face, and at the same time takes an impression of the surface markings of the breech face and firing pin, is dependent upon several things, chief among which are the material of which the primer is made, the hardness of this material, and the chamber pressure developed by the cartridge in question on being fired.

The cup of a modern primer is made of either copper or some copper alloy such as gilding metal or brass. Gilding metal, which is copper with from five to ten per cent of zinc in it, looks just like copper, and gilding metal primers are usually called copper primers. The copper is the softest and most ductile metal used for this purpose, and copper primers will take a deeper imprint of the firing pin, and will flatten more, and will take a better impression of the breech face than will brass primers. Sometimes the primers may be plated with nickel to prevent chemical action by some constituent of the primer mixture. For example, some primers contain fulminate of mercury, though this material is at present used much less than it formerly was. When the fulminate mixture is loaded wet, it will quickly attack the brass of the primer cup, and will cause the primers to become leaky or to develop pinholes or punctures when fired. To prevent this action, it has been common to nickel plate the primer cups. Then again, a primer that has no mercury in it may be nickeled in order to give it a pleasing appearance or to designate a certain type of composition used. Primers that are nickeled do not take the impressions of the breech face markings as well as do the plain copper or brass ones.

When a primer is struck by the firing pin, the very brusque and powerful mixture that it contains explodes with violence, and flashes through the small vent hole into the main body of the cartridge case, thus igniting the charge of powder inside. But the explosion of the primer mixture also reacts in a backward direction onto the primer cup itself, and blows it part way out of the primer pocket, unless the primer is strongly crimped in place, as is done with some kinds of rifle ammunition. Then when the main charge ignites, the powder pressure inside the case forces the case back sharply against the breech face or recoil plate, and this action seats the primer again. If an empty cartridge case is put in a gun and the primer is fired, the primer will often be found partly blown out when the gun is opened. This fact, which has proved to be

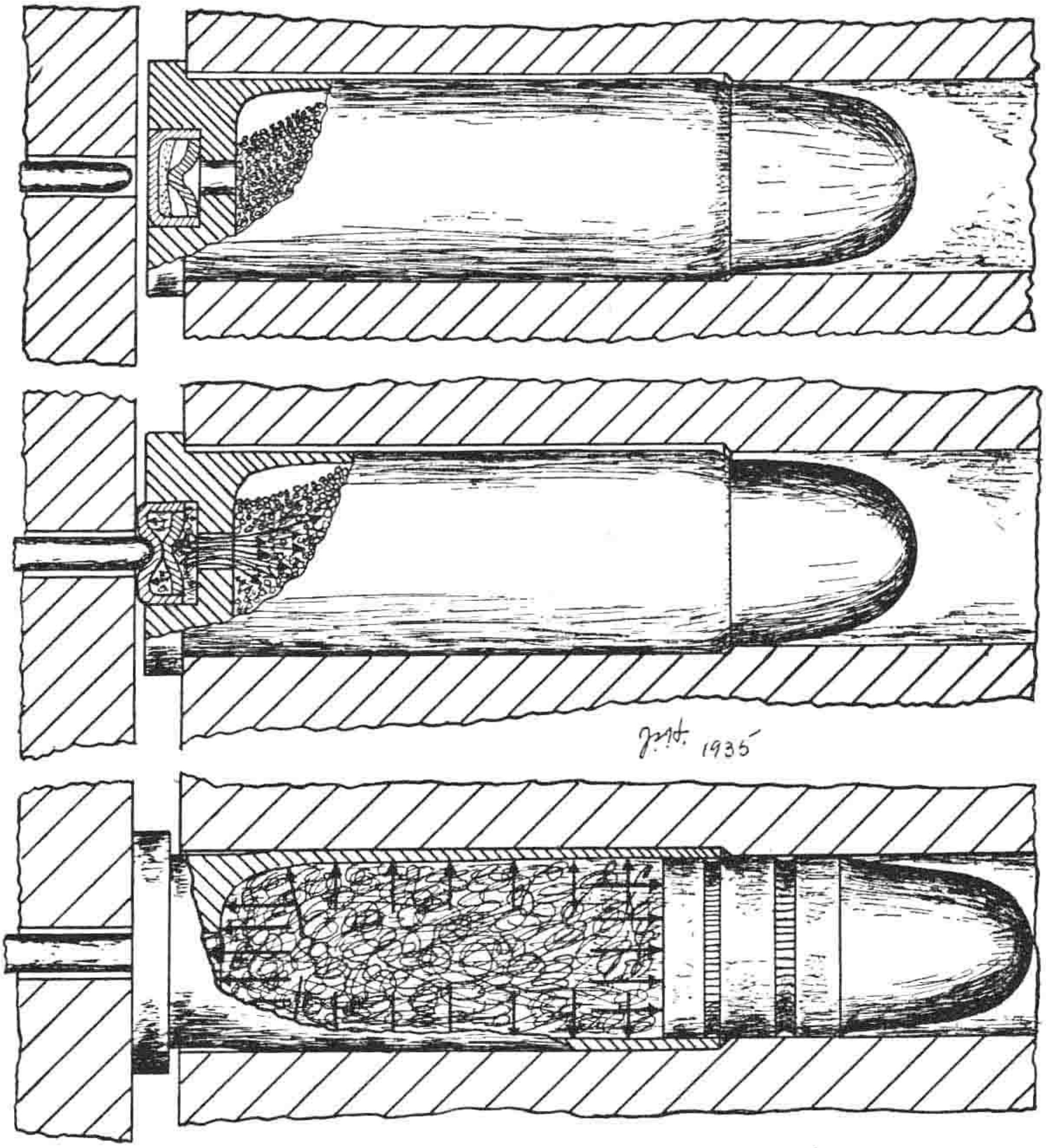


DIAGRAM OF WHAT HAPPENS WHEN A REVOLVER CARTRIDGE IS FIRED

Top. The cartridge is shown lying in the chamber of the revolver cylinder, ready to be fired. Naturally the cartridge must be somewhat smaller and shorter than the chamber, to allow it to be inserted at all, and as there is a variation in size of different chambers among the various makers, and even in arms of the same make, the cartridge may be quite a bit shorter and smaller than the chamber happens to be. This condition is shown in an exaggerated form in the sketch. The cartridge lies at the bottom of the chamber, and there is a vacant space both above the cartridge and behind it.

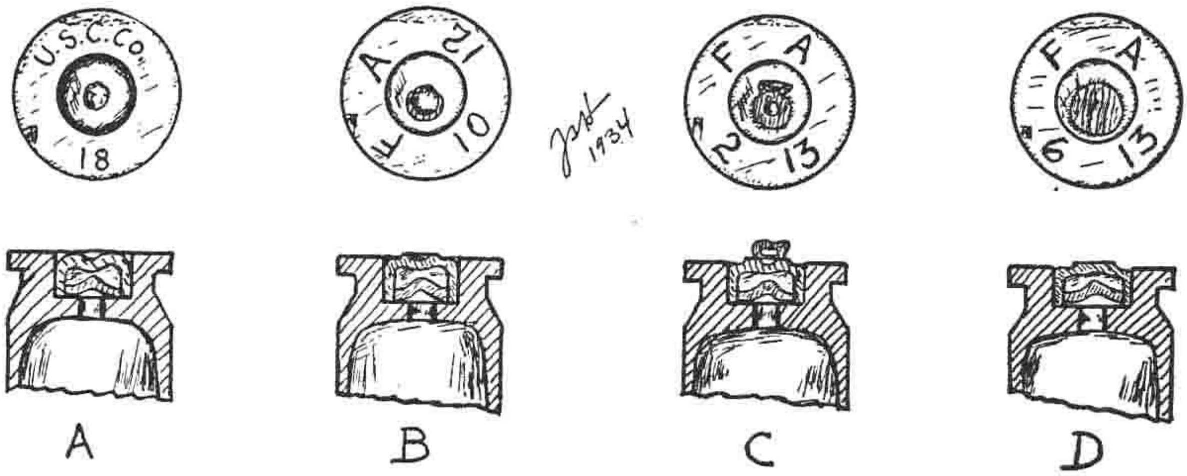
Middle. The firing pin strikes the primer. If the cartridge is not all the way forward, as shown, the blow of the firing pin will drive it as far forward and away from the breech face as it can go. The priming composition explodes, and the reaction of this brusque explosive drives the primer partly out of the primer cup and back against the breech face as shown.

Bottom. The flash of the primer has ignited the powder. The arrows indicate the powder pressure, which has driven the whole cartridge case back against the breech face thus smashing the primer against this surface, so that it takes the impression of any tool or file marks or other irregularities on this surface. The pressure is also driving the bullet out, and in doing so, it has straightened out the crimp in the mouth of the cartridge case. The impact of the gas on the base of the bullet, acting against the inertia of the bullet, "upsets" or expands the bullet so it is the full diameter of the neck of the chamber. The powder pressure, acting on the side walls of the case, which are thin and elastic, expands them until they bear tightly against the walls of the chamber and thus prevent the escape of gas to the rear.

a puzzler to many experimenters is due to the effect described above. If the vent hole between the primer and the body of the cartridge case is too small, this initial blowing out of the primer is more pronounced, and the primer may be found to be blown all the way out of the cartridge case, especially if there is excess headspace, (which means that the face of the locked bolt is too far from the head of the cartridge, and that the space provided for the head of the cartridge is too large. This condition may be due to wear or to the repeated effects of the powder pressure on the face of the bolt.)

It will be found that when a cartridge has been snapped in a gun, but misfires, the impression of the firing pin in the primer is much lighter than it is in the primer of a cartridge which actually explodes. This is because when the gun fires, the primer is driven back around the point of the firing pin, making the impression deeper. In the case of brass primers, the impression of the firing pin is usually shallower than it is with copper primers, and the primer is not flattened as much. However, the flattening of the primer is affected not only by the hardness and the nature of the material of the primer cup, but also in a large degree by the pressure. Thus when the breech pressure is high, the primer will flatten out more than it will with a low pressure, and for this reason the degree of flattening of the primer is often used by experimenters with firearms as a rough indicator as to whether or not the pressure is safe and proper. A close observer, who uses the same kind of primers repeatedly, can tell a great deal about the pressure in this way.

When the material of the primer is very soft, or the breech pressure is very high, or more particularly if the soft primer has a very strong mixture in it and the vent hole is small, the metal forming the surface of the primer cup often is forced back more or less into the firing pin hole in the breech block, thus leaving a raised rim all around the firing pin impression. With the .45 automatic pistol, the barrel swings downward when the slide recoils, so that the head of the cartridge moves downward over the face of the breech block for a short distance. This motion, combined with the extrusion of part of the primer surface into the firing pin hole, may cause the portion of the primer that is inside the firing pin hole to be either partly or completely sheared off by the edges of the firing pin hole. Sometimes the metal which is sheared off forms a small ring, and if the shearing is not complete, this ring may stick to the primer, giving a little upward projecting sharp lip. This shearing may take place on one shot and not on the next from the same gun; though as it depends a lot on the hardness of the primer material, it is likely to be found in some degree with all cartridges out of a box when it occurs on any of them. But the next box may not give any sign of it. The occurrence of such a little lip on both evidence and test cartridges has in some cases in the past been pointed to as proving that both cartridges were from the same gun. Naturally the well instructed investigator will make no such mistake. This effect may occur in almost any gun of this type. However, under the comparison microscope, the sheared surface of the primer may show identical groovings made by irregularities in the edge of the firing pin hole which shears off the projecting metal. This might be of very important assistance in making a positive identification.



DIFFERENCES IN APPEARANCES DUE TO VARIATIONS IN PRIMER HARDNESS. These four .45 caliber automatic pistol cartridges were all fired at the same time in the same pistol. A—Cartridge with brass primer. B—Cartridge with cooper primer. Part of the primer has blown back into the firing pin hole, and then has been sheared off when the head of the cartridge was slid downward over the face of the breech by the downward swing of the barrel in unlocking. C—Still more of the primer surface has been forced back into the firing pin hole, and a little annular ring of metal which was sheared partly, but not completely off, may be seen adhering to the top of the primer. D—A considerable portion of the primer surface has been forced into the firing pin hole, and then sheared completely off, leaving a freshly cut metal surface exposed to view, with distinctive streaks left by irregularities in the edge of the firing pin hole which did the cutting.

This same downward motion which shears off the projecting primer metal may be responsible at times for a little gouge on one edge, (the top) of the firing pin impression in the primer. This is caused by the fact that the firing pin may not be retracted before the downward motion of the barrel begins, and the projecting point of the firing pin therefore may rake over the edge of the impression as the case slides downward. This little gouge, or lip, has also mistakenly been pointed to in the past as indicating that a certain cartridge was fired from a certain gun. Nothing could be more unfortunate than such a conclusion, for this nick may be made by any .45 automatic or Super .38. Naturally no such error would be made by anyone who had given the subject of firearms identification any degree of study at all, but as the author knows of cases where it has been done in the past, it is referred to in this place.

Did the Fatal Bullet Come from the Suspected Gun?

It frequently occurs that a fatal bullet is recovered and it is desired to say whether or not this bullet was fired by a weapon found on a suspect. With modern methods it is often possible to give a definite answer to this question, and it should be noted here that it is just as important to be able to say that a bullet did not come from a given gun as to say that it did. The science of firearms identification is a most important asset to the innocent suspect, for it gives him an absolutely infallible method of proving his innocence.

In some cases, it may be necessary to clean up the bullet before this examination can be made, for very frequently it may be so covered with clotted blood, and other such substances, that examination of the markings is impossible. In these cases, it must be very carefully cleaned, with due precaution against anything that may possibly be construed as changing the evidence. It is common practice to soak the bullet in Xylene to dissolve and remove the lubricating grease, and in salt solution to dissolve and remove the clotted blood. Neither of these solvents will change the bullet itself in any way; after the removal of these foreign substances, the bullet is in condition to be measured and examined.

In a case of this kind, the first thing to do is to determine whether or not the bullet came from the same class of weapon; that is, whether or not it contains the class markings of the gun in question. Obviously if the bullet is of a larger caliber than the gun, or if it has a different number of lands and grooves on it from the gun, or if the pitch of rifling is in a different direction, it did not come from that gun.

On the other hand, if all class marks are the same, such as diameter, pitch of rifling, direction of rifling, number of grooves, width of lands and width of grooves, the presumption is strong that the bullet did come from a gun of that particular type. This does not, however, prove in any way that it came from that particular gun as there are hundreds or even thousands of guns of each type manufactured.

Fortunately, however, each and every barrel has its own "finger prints" which it leaves on a bullet, and identification by these marks is just as certain as identification of a criminal by his finger prints.

A rifle or revolver barrel is made from a solid steel forging. The first step is to drill a hole all the way through from one end to the other. Then the next step is to ream this hole very carefully to exactly the correct bore diameter. This reaming leaves circular marks round and round the barrel, caused in part by irregularities of the cutting edge of the reamer and partly by little chips of steel that get caught by the reamer and drag around with it. A finished reamed bore before rifling looks smooth and glassy to the naked eye but when examined by a high powered microscope these marks show up in very pronounced fashion.

After the reaming has been finished the next step is to put in the rifling. There is a rod that fits the inside of the bore and this rod has in one point of its circumference a small blade that scrapes away a part of the metal as the rod is drawn through the barrel. In order to give a twist to the rifling the rod is rotated at the same time it is drawn through. The amount of metal taken off by this little cutter as it goes through is small (about one twenty-thousandth of an inch in the Springfield rifle, which has grooves four thousandths of an inch deep, and which requires eighty strokes to make each groove).

As the cutters are pulled through, they scrape away the surface of the steel, and no matter how hard the maker may try to make an absolutely smooth job of it, there will be many little rough spots, or microscopic gouges or elevations, left on the surface as the outer layer of metal is torn away by the cutter as it plows its way along. Moreover, small chips of steel torn off the surface may become wedged under the edge of the cutter for a time, and this may result in rough spots. Thus the grooves, which may appear smooth to the unaided eye, actually have a surface which contains many small irregularities.

Now when a cartridge is fired in the completed gun, the bullet, which is larger than the bore diameter, or distance from one land of the rifling to the one directly across from it, is forced into this smaller barrel, and the lands of the rifling bite into the bullet and embed themselves into its surface. Moreover, the bullet received the impact of the powder pressure of from 10,000 to 50,000 or more pounds per square inch on its base, and it will usually "upset," or expand in diameter, more or less, and will therefore tend to more or less fill the grooves of the rifling, even if it is not at first of full groove diameter. Lead bullets, which expand or upset easily, usually fill the grooves completely, while metal jacket bullets usually fill the grooves in the center, but may not touch the bottoms of the grooves at the edges. In any event, the bullet in passing through the barrel, is in intimate and forcible contact with the surface of the lands, and with more or less of the surface of the grooves, and the irregularities of the surface will leave a series of scratches on the surface of the bullet. In general, the pattern of scratches or striations on any one land or groove mark of the bullet will be entirely different from those of any other land or groove mark; and no land or groove mark on a bullet fired from one gun may be expected to have a pattern that will match perfectly the pattern on any portion of a bullet fired from a different gun. On the other hand, if two bullets were fired from the same gun, there should be a general correspondence between the pattern of *each* land and groove mark on one bullet with the marks left on the other bullet by the same *land* or groove. In general, the marks left by the lands are the more distinct, especially on metal jacketed bullets, because the lands bite deeply into the bullet, while the surface of the grooves may at times hardly more than touch the bullet at the center of the grooves.

If several bullets are fired from one gun it will be seen that the same small scratches or striations will be found on each of these bullets. In examining a fatal bullet to determine whether or not it came from a given gun, several test bullets of the same kind of ammunition and as nearly as possible the same date of manufacture are fired from the suspected gun into cotton waste and then recovered for examination.

It may be stated here that a box forty-eight inches long full of loose cotton waste will stop any pistol bullet, and the proper way to recover bullets is to place the muzzle of the gun within a few inches of this cotton and fire straight into it. By digging into the cotton waste the bullets can be recovered entirely uninjured and with all the marks intact.

It is quite important that the test bullets should be as nearly like the fatal bullet in every respect as is possible. They should be from ammunition of the same kind and type, and if possible should be of the same make and as nearly as possible of the same period of manufacture, as that from which the fatal bullet came; and it should of course be loaded with the same type of powder, that is either black or smokeless. Of course in many cases it will be impossible to know the date of manufacture, or even the make of the fatal cartridge; but the caliber and general type can always be determined, and the test bullets should always be as nearly duplicates as is possible.

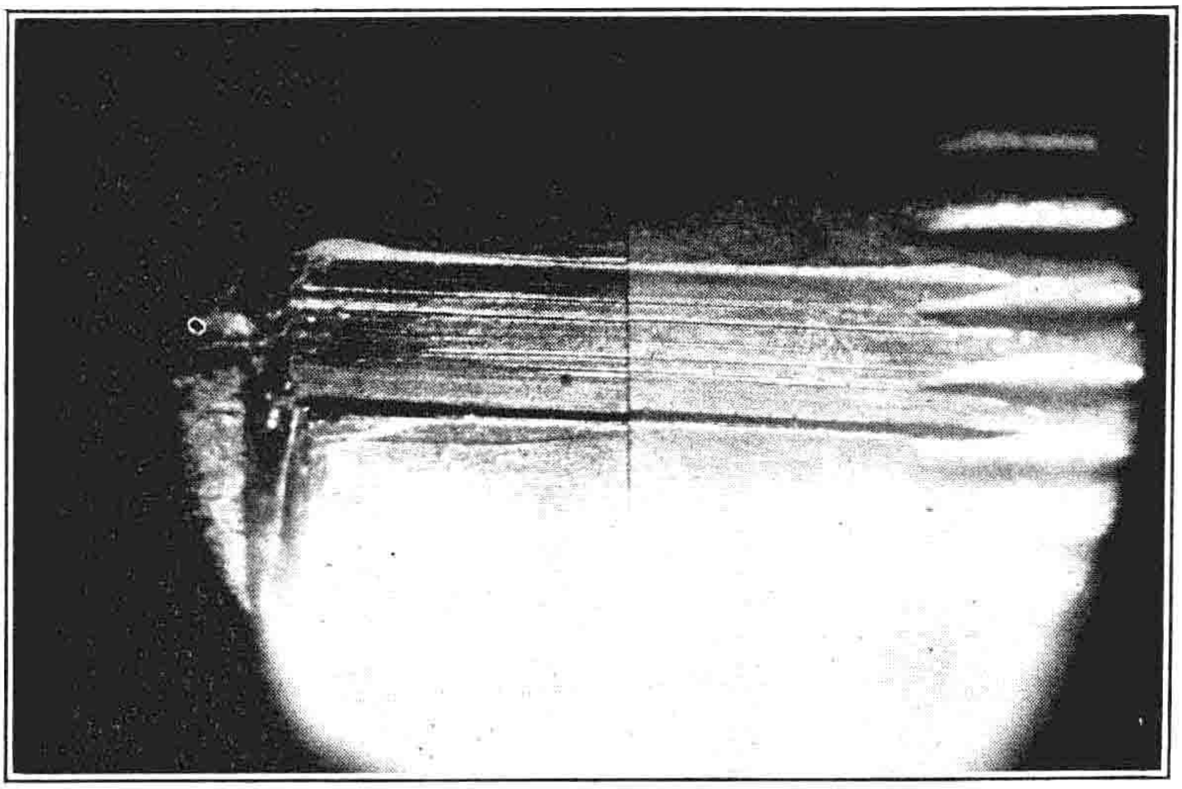
In firing test bullets, it is a convenience to make a distinct identifying mark on each one, and to place these marks always in a corresponding position in the gun. Thus it will always be possible to say which land or groove marks on the test bullets have been made by the *same* lands or grooves in the gun, and these can be placed together for examination without wasting time to make a search under the microscope to find the right ones to compare.

The examination of the evidence bullet against the test bullets is now made with the comparison microscope. The first thing to be done is to mount two test bullets for examination. There are a number of bullet holders of different sizes furnished with the Spencer Comparison Microscope, and there are two complete sets, one with five sets of numbered markings, for bullets fired from a gun with five grooved rifling, and another with six. There are also two index drums, to go onto the revolving spindle on which the holders are placed under the microscope. These drums also come in two series, one set for five grooved and the other for six grooved bullets.

First see whether the bullets have five grooves, or six, and place the proper set of index drums on the microscope. Then select two bullet holders of the same diameter as the bullets, and carefully stick the bullets in place with plasticene, which is a modelling clay mixed with cocoa butter as a base, so that it never hardens. Great care must be used in lining the bullets up so that the axis is central with that of the cylindrical holder, and in the same line.

In placing the test bullets on the holders, arrange them so that in each case, the marked land and groove impression is opposite the No. "1" engraved on the holder. Then slip the holders onto their spindles on the microscope, and turn the spindles until the same number is uppermost on each holder. The microscope lights are turned on and adjusted so that the bullets appear well illuminated. The bullets are now obeserved through the microscope eyepiece, and are brought to the proper focus by turning the knobs which raise or lower the stage; or, in those models of microscope in which the stage is fixed, by raising or lowering the microscope body by the knob provided for this purpose, until the focus is correct, and every detail of the surface can be plainly seen.

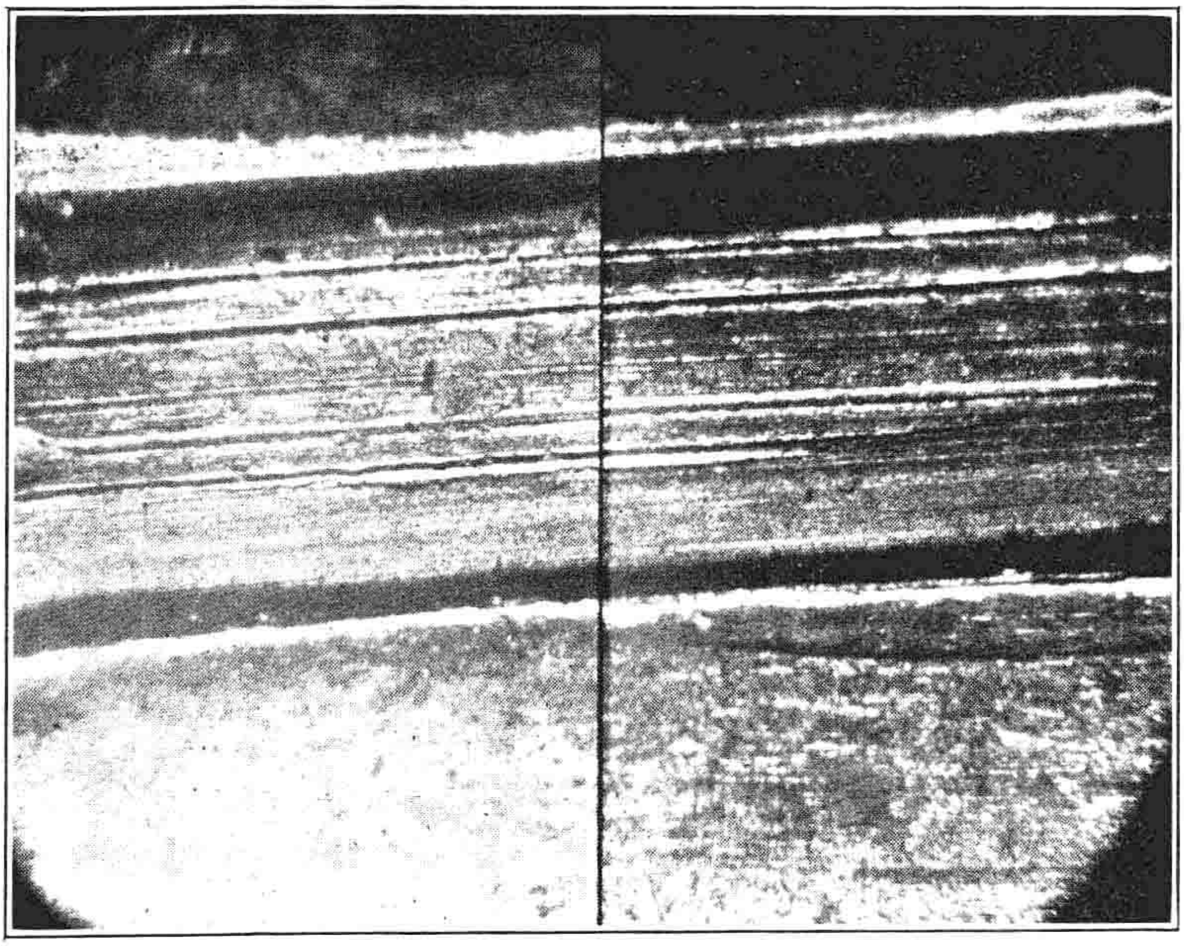
At this point adjustments must be made by means of the knobs of the mechanical stage so as to bring the bullets into the center of the field of view, and so as to bring both bullets into line, and also so as to bring a corresponding part of each bullet against the dividing line between the two fields of the comparison ocular, so that the parts of the two bullets that can be seen through the ocular appear in outline as one bullet divided by a line where the fields of view join.



Photograph through comparison microscope showing a test bullet (left) and fatal bullet (right) from the Imperial Valley Murder Case. The gun was a .25 caliber Colt Automatic, brand new. Photos by Capt. Edward C. Crossman, Firearms Expert.

The test bullets are now examined and compared, land for land and groove for groove, to note what identifying correspondences exist and what differences can be found. This will give the investigator exact information as to just how two bullets from this gun will compare under the microscope.

The next thing to do is to remove one test bullet and place the evidence bullet on the holder in its place. Then one bullet is kept stationary, and the other is rotated until the raised portions and the grooves left by the rifling line up and seem to be continuous through both fields of view. If both bullets have been fired from an arm of the same caliber and make, each land or groove mark on the rotating bullet, as it passes a land or groove mark on the stationary bullet, will blend with it as to width and angle of pitch, and it will seem as though one groove or one ridge crosses the images of both bullets. However, the blending will not be complete, for their are a large number of longitudinal grooves, ridges, scratches, etc., much smaller than the main rifling marks, and these will not blend unless the bullets have been fired from the *same identical arm,* and have been rotated to the *same identical position.*



Another land imprint on the .25 caliber A. C. P. bullet from the Imperial Valley Murder Case. Right, fatal bullet, left, test bullet. Photo by Capt. Crossman. To better see the agreement of the markings on these three photos, look at each picture from the end of the markings so as to look along each mark.

The endeavor of the expert, in comparing bullets as described above, is to find out whether or not there is any position to which the two bullets can be rotated so that the finer scratches and striations mentioned in the previous paragraph will blend together in the two images. If any such position is once located, the two bullets are then revolved together, and the marks should blend in all positions of the two bullets, as long as corresponding land and groove marks are kept together. It is for convenience in keeping the bullets in the same relation as they are revolved, that the numbered land and groove marks are placed on the bullet spindles and on the index drums for each spindle.

When two groove marks have once been found in which all the finer scratches blend, as described, one of the bullets is held stationary and the spindle attached to it is rotated until the index number corresponding to the groove mark in question is the same as the index number corresponding to the mark on the other bullet. Thus grooves numbered alike on the two bullets will correspond all around, and whenever two correspondingly numbered lands or grooves are brought uppermost for examination, the general pattern of marks should blend on both bullets. If such an agreement is found in every corresponding position of the two bullets, the conclusion that they must have been fired from the same identical barrel is irresistible.

There will always be several test bullets available, and it is good practice to compare the evidence bulllet with all of them. Thus the operative will not be open to the charge of considering only that part of the evidence which suits his purpose. Moreover, it is excellent practice to compare the evidence bullet not only with test bullets from the suspected arm, but also with *others of the same type*. Then if he obtains a match, he can show not only that the evidence bullet does correspond with recovered bullets from the suspected arm, but also, that conversely, it does not correspond with test bullets from other arms of *exactly the same type*. While the trained expert may not need any such procedure to satisfy himself of the identity, the fact that the bullet which matches the suspected arm *does not* match others exactly like it will often go a long way toward convincing the jury of the facts in the case.

Of course, if there is marked dissimilarity in the general pattern of fine scratches or striations at any corresponding position of the two bullets, it may throw a considerable degree of doubt on the validity of the identification; but the investigator and the legal authorities should realize clearly that the mere presence of a particular mark on one bullet that is not continued onto the other one does not necessarily have any bearing at all on the case, for it is quite usual for some marks to appear on each bullet that are not reproduced on the other. These are the accidental marks due to foreign substances which are present for that one shot only, such as for instance, a sliver of steel, a bit of sand, a particle of rust, or in short, any such particle of material that may be either in the barrel, in the powder, or embedded in the bullet. Such accidental marks should be disregarded, and their accidental character can be clearly shown if they happen to appear on the test bullet, for the same marks will not appear on other test bullets fired from the same arm.

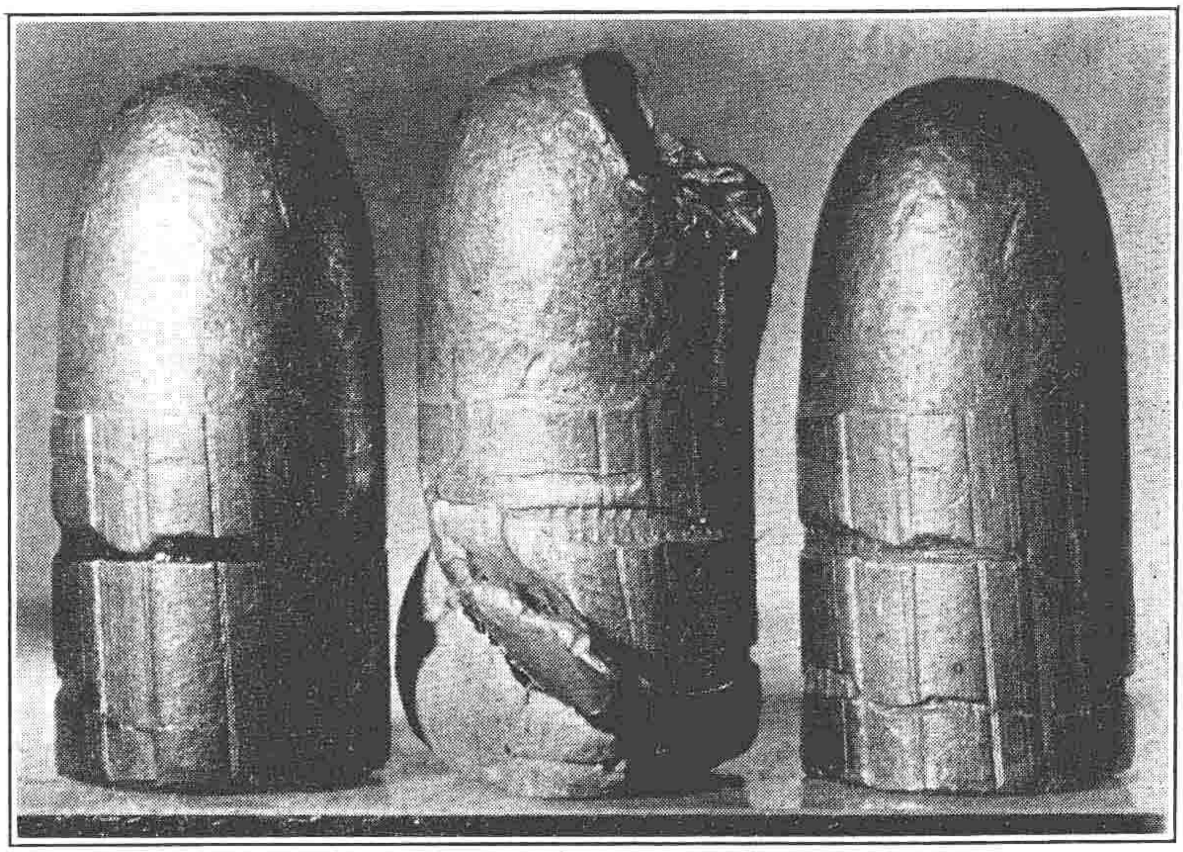
Occasionally, also, the bullet may be badly marred or scratched by rough handling with the forceps of the post mortem physician; but in the larger cities, and under the jurisdictions of the better informed coroners, this mutilation of the evidence bullet by the carelessness or indifference, or perhaps, more correctly, the ignorance, of the physician, is becoming rarer. Some very well informed officials have required the use of rubber tipped forceps for removing bullets.

Even less excusable is the marking of the evidence bullet for identification by making some coarse scratch right over the most important markings. The author has seen cases where this was done, and the most unfortunate phase of the matter is that with ignorant or prejudiced or distrustful jurors, the explanation of these marks is often regarded with suspicion. The juror does not see the same mark on the test bullet, and therefore he will perhaps refuse to believe the identification.

In the manner described above, it is often possible for the investigator to determine with certainty whether or not a given bullet came from a particular gun, provided only that the arm is in fairly good condition. Arms that are very badly worn, or cheap arms that have loose barrels, may make identification very difficult; and the same thing is true of very badly mutilated or smashed evidence bullets. The author has seen a murder bullet that was so badly mashed by striking first bone and then a brick wall, that only a part of one groove remained to view. Badly rusted arms may render identification difficult by changing from shot to shot, as the rust is shot out.

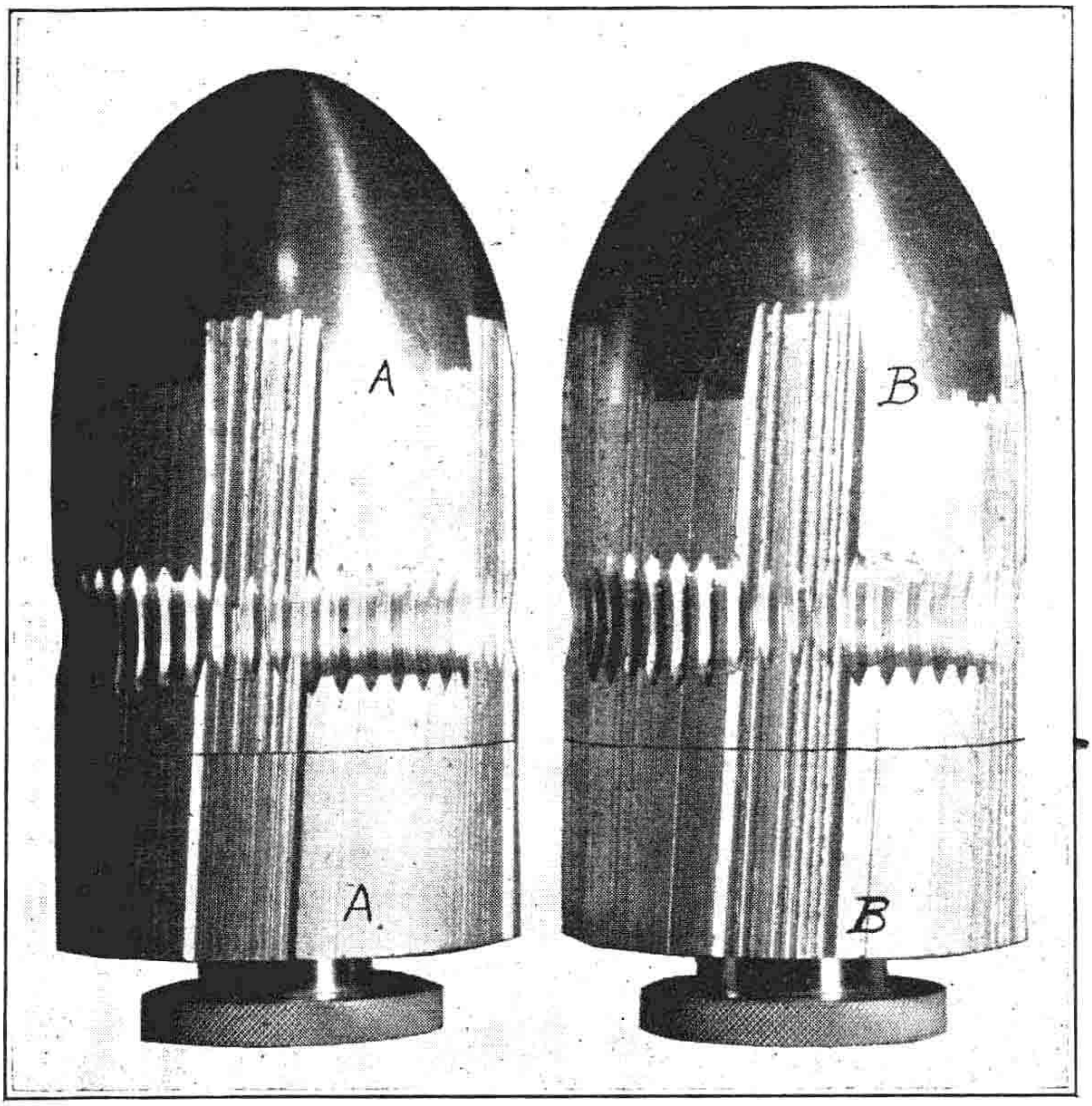
Lead bullets, fired with smokeless powder in well made arms, take the best impressions of all the marks in the barrel, while jacketed bullets often fail to fill the grooves, and in any event, do not take as good an impression as do the lead bullets. But this is counterbalanced by the fact that the jacketed bullets retain their markings better. Even after impact with hard ground, or in cases where a soft point bullet has struck bone and turned inside out, sufficient markings for identification will often remain. Often jacketed bullets can be identified under the most difficult conditions.

After the investigator has found that the bullets do or do not match, the next thing is to record the findings photographically. Photographs taken through the comparison microscope with the two bullets in place and the lines matched up are made, and in addition, large photographs showing the entire bullets are made by means of the bullet photographing stand and the camera with short focus lens. With a reasonable degree of skill, it is possible to make photographs that will readily enable the court and the jury to understand the result.



Photograph of the bullets in the Beitzel case. Note how the fatal bullet (center) is deformed by contact with hard objects during flight. In spite of the mutilation of the bullet, identification is easy. Photo by Capt. Crossman.

Different experts have their own preferred methods of presenting this material. One expert will take six photographs of each bullet, one showing each groove mark, and he will thus have twelve prints, six of the fatal bullet and six of the test bullet. These twelve prints are properly marked, and are mounted in a folder or booklet. In addition, twelve loose prints are furnished, also properly marked. The loose prints can thus be cut across with shears and the cut portions matched with the corresponding pictures of the other bullet, superimposing cut portions of the prints of the test bullet onto corresponding photographs of the fatal bullet, and vice-versa. By this method, members of the jury



A very useful device for illustrating the principles of bullet matching to a court or jury is a pair of large model bullets with the base part detachable, as shown. By unscrewing the knurled nut at the bottom, the lower part of the bullet is loosened, and may be turned on its axis. The members of the jury may be allowed to turn the lower part until the various scratches, etc., match up with those on the upper part, thus giving them an excellent idea of how the bullet comparison microscope does its work. But when the lower part of bullet A is placed on Bullet B, and vice-versa, no match can be had.

can perform these experiments for themselves, and can see just how much correspondence there is between the patterns on the two bullets at all positions.

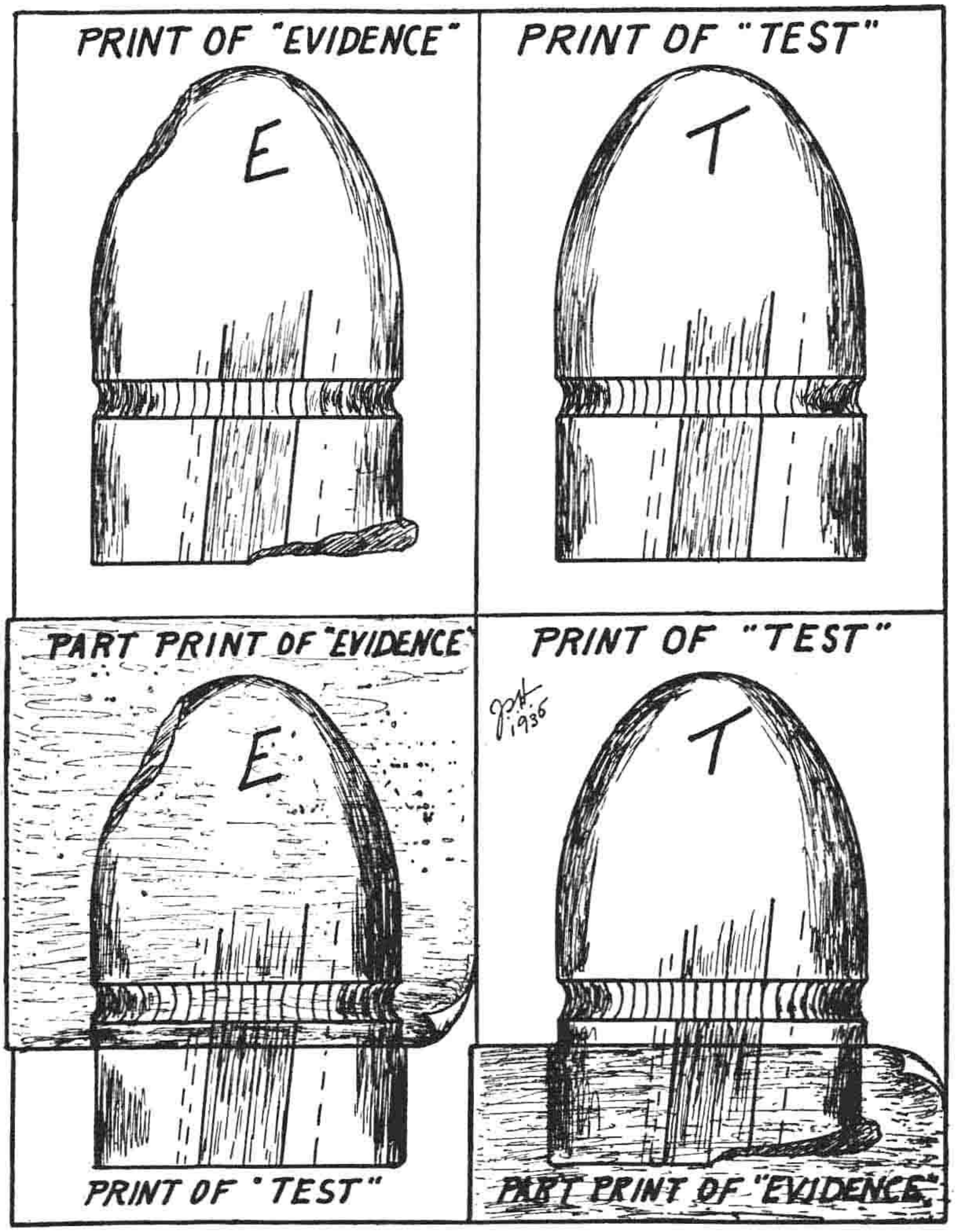
Another expert will prefer to take three identical photographs of the fatal bullet, and two of the test bullet, which he will use as follows. He will paste four of the pictures onto a sheet or folder in the following order; from left to right, numbers 1 and 2 are photographs of the fatal bullet and the test bullet, respectively; while numbers three and four are pictures of the fatal bullet. The remaining print, which shows the test bullet, is cut across, and the lower half is superimposed over the lower half of picture No. 3, of the fatal bullet, and the top half is superimposed over the top half of picture No. 4 of the fatal bullet. In both cases, the lines will blend and thus prove identification.

While we are on this subject, it is well for the reader to get firmly in mind that any photographs which are intended to be introduced as evidence cannot be retouched in any manner whatever, for if this is done, it is no longer a true photograph of what the camera actually saw, but instead is a mixture of what the camera recorded and what the retoucher thought ought to be there; and what the artist thought the picture ought to look like is not by any means admissible as evidence.

In connection with this work, the investigator may, and most likely will at times, encounter a most determined effort on the part of opposing counsel to throw doubt on the validity of any identification of a firearm by means of an evidence bullet, and to discredit the whole science of firearms identification. Often implications or statements are made to the effect that as the operator cannot possibly have examined all the guns in existence, he has no way of being certain that a bullet from some other arm might not match the evidence bullet equally as well as does the one from the arm involved in the case.

Occasionally these efforts may meet with quite a degree of success; yet the same attorney who questions the identification of a bullet will perhaps be quite willing to have a witness put on the stand for the purpose of identifying some person whom he may have seen only once before in his life, and perhaps on a distant date.

It can readily be shown that the identification of two bullets under the comparison microscope depends on factors that are much more exact than are those involved in the identification of a person from the memory of how he looked when seen at some previous time. The two bullets are seen side by side at one time in the field of the instrument, and the operator has unlimited time and opportunity to make a searching comparison of definite marks and patterns, instead of having to depend on his memory of utterly indefinite differences in appearance for his identification, as does the witness who identifies a person from a single previous view. Here the science of bullet identification has far and away the better of the argument, yet men have been hanged on no better


PRINT OF "EVIDENCE"
PRINT OF "TEST"
E
T
PART PRINT OF "EVIDENCE"
PRINT OF "TEST"
1936
E
T
PRINT OF "TEST"
PART PRINT OF "EVIDENCE"

ONE METHOD OF PRESENTING PHOTOGRAPHIC EVIDENCE.

One print of the "evidence" bullet, (upper left), and three identical prints of the corresponding view of the 'test" bullet, (upper right, lower left and right), are pasted onto a large piece of cardboard, as shown, and introduced, together with several extra copies of the print of "evidence" bullet. These loose prints of the "evidence" bullet may be cut across and laid on top of the mounted prints of the "test," thus showing clearly how the "test" and "evidence" bullets match.

evidence than the recollection of their appearance by someone who saw them only once before.

The firearms witness may expect to be asked how he can be sure of his findings, in view of the fact that he can have examined only a few of the countless thousands of guns that exist. But how does our witness that identified the prisoner know that some other person may not look exactly like him? He will say that he has seen enough people in his life to know that the rule is that all people look different, and that the chances are overwhelmingly against finding two people who look so much alike that they cannot be told apart.

In precisely the same way, the firearms expert, who admittedly cannot have actually examined more than the tiniest fraction of a percent of all the guns in the world, can still have had enough experience to be well aware of what differences do occur, and to know that the chance of finding two bullets from different guns that are exactly alike in every detail of their surface markings is infinitesimally small. The same thing applies with equal force to the finger-print method of identification. No finger-print man has ever examined more than the slightest percentage of all the finger prints in existence, yet the finger-print worker knows from the many examinations that he has made, that the rule is that all finger prints are different. There may possibly be some that are alike, but the chances of such an occurrence are small.

This whole question is intimately connected with the theory of probabilities, and because he may possibly be subjected to cross-examination designed to expose his unfamiliarity with this subject, the firearms expert will do well to get out his advanced algebra and brush up once more on what he learned in school on that subject.

The theory of probabilities is founded on the fact that if there is an equal chance of having a thing happen in any one of several different ways, then the chance that in any particular case it will happen in a certain designated one of those ways is unity divided by the number of ways it can happen. Further, if there are several different possibilities involved, the chance of their all happening in the designated way is the product of the chances of each separate happening, all multiplied together. Thus dice have six sides, and any side can equally well be uppermost on any throw. Therefore the chances of getting say a six on any one roll of a single die is 1 in 6, and the chance of getting three sixes if three dice are rolled at once is 1/6 x 1/6 x 1/6, or 1 in 216. If a coin is tossed, the chances are 1 in 2 that it will come heads. Therefore, if three dice are rolled and a coin is tossed at the same time, the chances of getting three sixes and "heads" at the same time are 1/216 x ½, or 1 in 432.

The same laws apply equally well to the occurrence of combinations of markings on bullets. If when a certain mark appears on a bullet it has a certain exact location on the bullet 1 in 400 times, and if only 1 in 600 arms gives this kind of mark, then the chances of finding another bullet with the same mark in the same location are 1 in every 600 x 400 arms tested, or 1 in 240,000. Now suppose that this mark is of a certain depth, and that only 1 in 10 of the marks of that kind are of that exact depth. Then the chances of finding a mark of that kind and depth in that location on the bullet are 1 in every 2,400,000 arms tested. But suppose that there are 120 such marks around the entire circumference of the test bullet and the evidence bullet. The chances of finding another gun that will make every mark exactly like those on the bullet in question will be 1 in 120 x 2,400,000 or 1 in 288,000,000 arms tested. Surely, these are sufficiently great enough odds as they stand at this impressive figure. But they may logically be carried still further by supposing that this arm is of a certain caliber, with a certain kind of rifling, and that only one man in 1500 has such a gun. Then our chances of finding a man whose gun will duplicate the bullet in question becomes 1 in 1500 x 288,000,000, or 1 in 432,000,000,000 men examined.

Of course the details given in this discussion are all purely speculative, for no data are available as to the exact probability of the existence of any particular mark at any definite location on a bullet; but the discussion is intended to show how the mathematics of the theory of probabilities work in a simple case. It is precisely these principles that cover the practice of basing a conviction on circumstantial evidence. If the number of the circumstances surrounding a crime all point to a single suspect, the chances that anyone else can have done it become increasingly remote as the number of incriminating circumstances increases. It is the same way with the occurrence of coincident marks on bullets. It may be quite common for two or more prominent individual marks on bullets from two entirely different guns to match exactly, but the chance that there will be a correspondence of a great many of the individual characteristic marks on two bullets that came from different guns is so remote as to amount to a practical impossibility.

DIFFICULTIES ENCOUNTERED IN THIS WORK

When the technique of bullet or cartridge case identification is described as has been done above, it will seem to the reader like a very simple and easy procedure, and in fact, it is when the conditions are all favorable; but usually the conditions are far from ideal, and the obtaining of any identification at all may in some cases present a formidable problem, capable of solution only by the most skillful technician in this work, or perhaps not capable of any solution at all.

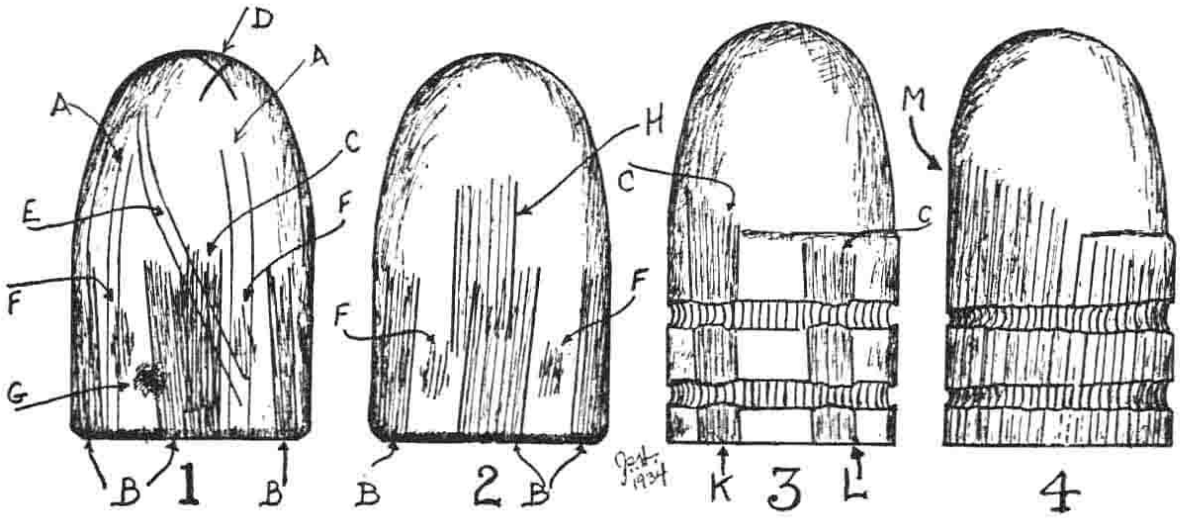
The work of cartridge case identification is the most likely to present serious difficulties, for the degree to which markings are impressed on the heads of cartridges varies greatly with different makes and conditions of cartridges. The author has seen four old shotgun cartridges fired in a nearly new repeating shotgun which showed not the slightest trace of any breech-face markings; while cartridges of other makes, fired in an exactly similar gun took a beautiful impression of the breech face irregularities. These old cartridges were absolutely impossible to identify, though they were afterwards proved to have been fired in this gun; and other cartridges from the same box also failed to take impressions when fired in other guns. In general, there is quite a variation in the degree to which different makes and types of cartridges will be marked, and this emphasizes the necessity of using cartridges of the same make and lot number for any check tests of any kind that may be made in connection with any phase of firearms investigation. For example, if it is desired to see how far away the gun must be to make certain powder burns, the type and lot number of the ammunition used in the check tests must be exactly the same, and the gun must be of the same type, as the ammunition and gun respectively, which are involved in the case. The importance of this point is emphasized by the experience of the author in making some comparative tests of this kind in a .380 automatic pistol with several makes of cartridges. One make caused a profusion of unburned powder grains to be imbedded in the target around the bullet hole when the gun was fired at a distance of eight inches, and another make of cartridges failed to show the slightest trace of powder markings when fired at two inches. Both lots of cartridges were of modern manufacture, and both were loaded with smokeless powder, but one was loaded in America and the other in Germany.

When it comes to bullet identification, serious difficulties are sometimes presented by the extreme deformation of lead bullets and the consequent obliteration of the markings.

Very often the shooting is done with some old, cheap revolver in which the barrel is a loose fit on the bullet, and in which the cylinder fails to line up properly; and in such cases, there may be absolutely no appearance of any land and groove marks at all on the bullet, though generally the surface may be covered with fine spiral lines, which may render identification possible. If the cartridges are loaded with black powder, the barrel is likely to be caked with residue, and the marks left by the caked powder ash are likely to make the surface of the evidence bullet differ considerably from that of the test bullet fired later. The same thing is true of bullets which are fired in a gun where the barrel is badly rusted. The rust deposits will leave decided marks on the surface of the bullet, but the firing of several bullets through the barrel may decidedly change the character of the markings owing to the fact that the friction of the bullet's passage through the barrel may scour away the rust, so that succeeding bullets are not marked in the same way.

The way in which the use of an old and rusted barrel may affect the work of identification is well illustrated by a recent case in which the defendant was known to have had a quarrel with the deceased, accompanied by physical violence, during which the deceased threw the defendant out of his place of business. The defendant was admitted to have gone home and procured an old and rusty revolver which he owned. The deceased was then shot dead, by a person unknown. The expert found that the cylinder of the old revolver fitted badly, and that the barrel had a prominent rust patch in it. The fatal bullet was mutilated as though the cylinder had been poorly aligned at the instant of firing, and the fatal bullet bore marks that corresponded to the size and location of the rust patch in the barrel. The expert fired one bullet through the barrel, and secured a positive identification, but then he proceeded to fire fifteen more shots. The friction of the bullet in passing through the barrel had removed the rust spot, and all bullets were so badly mutilated by the misalignment of the cylinder that identification could not be obtained except on the first one.

The expert testified that he had obtained identification on the first bullet fired. Cross examination asked whether or not he had fired additional bullets. He replied that he had fired fifteen in



TYPICAL MARKINGS ON RECOVERED BULLETS

1. Bullet from a .45 caliber automatic pistol. A, A—Scratches produced during the operation of drawing the jacket during manufacture. They have no bearing on identification. B, B—Marks left on the bullet by the lands of the rifling. The width, depth, inclination, and number of these marks are class characteristics which may give the investigator a clue to the type or make of weapon used, or both. The surface of this mark is composed of parallel lines, scratches, and marks, and the pattern formed by them is an individual characteristic of the particular gun through which the bullet was fired, and forms the basis of the definite identification of the particular gun which fired the bullet. The lines forming this pattern are parallel to the DRIVEN EDGE of the land mark, which is the edge toward which the mark slopes when viewed from the base of the bullet. (In this case, the left hand edge.) C—"Skid Mark" caused by the failure of the bullet to take up the rotation as soon as it struck the rifling. It consists of lines parallel to the axis of the bullet on the TRAILING EDGE of the land mark, which is the side that the mark goes away from when viewed from the base of the bullet. D—Identification marks scratched on the bullet by police officials. E—Scratches made after the bullet left the gun, probably by contact with pieces of gravel or something of the kind. Note that these marks have an inclination to the axis of the bullet greater than the angle made by the rifling marks, which cannot be the case with any mark whatever which is made while the bullet is passing through the gun. F, F—Marks left by contact of the bullet with the bottoms of the grooves. They may assist in the individual identification of the bullet, but are neither as important nor as trustworthy as the marks left by the surface of the lands. G—A depression left in the surface of the bullet by a "stab mark" used in holding the bullet in the neck of the cartridge case.

2. A bullet from a .45 caliber S. & W. Model 1917 revolver. B, B, and F, F, same as already described under 1. H—An additional rifling mark, which has a different angle and extends higher on the ogive than the regular rifling marks. This is caused by the fact that the bullet struck the forcing cone, or origin of the rifling, AT AN ANGLE TO THE AXIS OF THE BORE. This imprinted the extra rifling marks on those parts of the bullet ogive that are furthest from the axis of the bore. As the bullet enters the bore, it is forced to right itself, and the regular rifling marks are then made. The investigator should become thoroughly familiar with this appearance on actual bullets, as these additional land impressions are often seen.

3. A .38 Special bullet with some of the rifling marks longer than others, showing that it entered the barrel parallel to the axis of the bore, but slightly to one side of the center. This is very common with revolvers, and always happens when the cylinder fails to line up perfectly. C, C—Same as described under 1. K—A land impression that is considerably longer than the average, showing that the bullet was closer to this side of the bore than to the other. L—A shorter land impression.

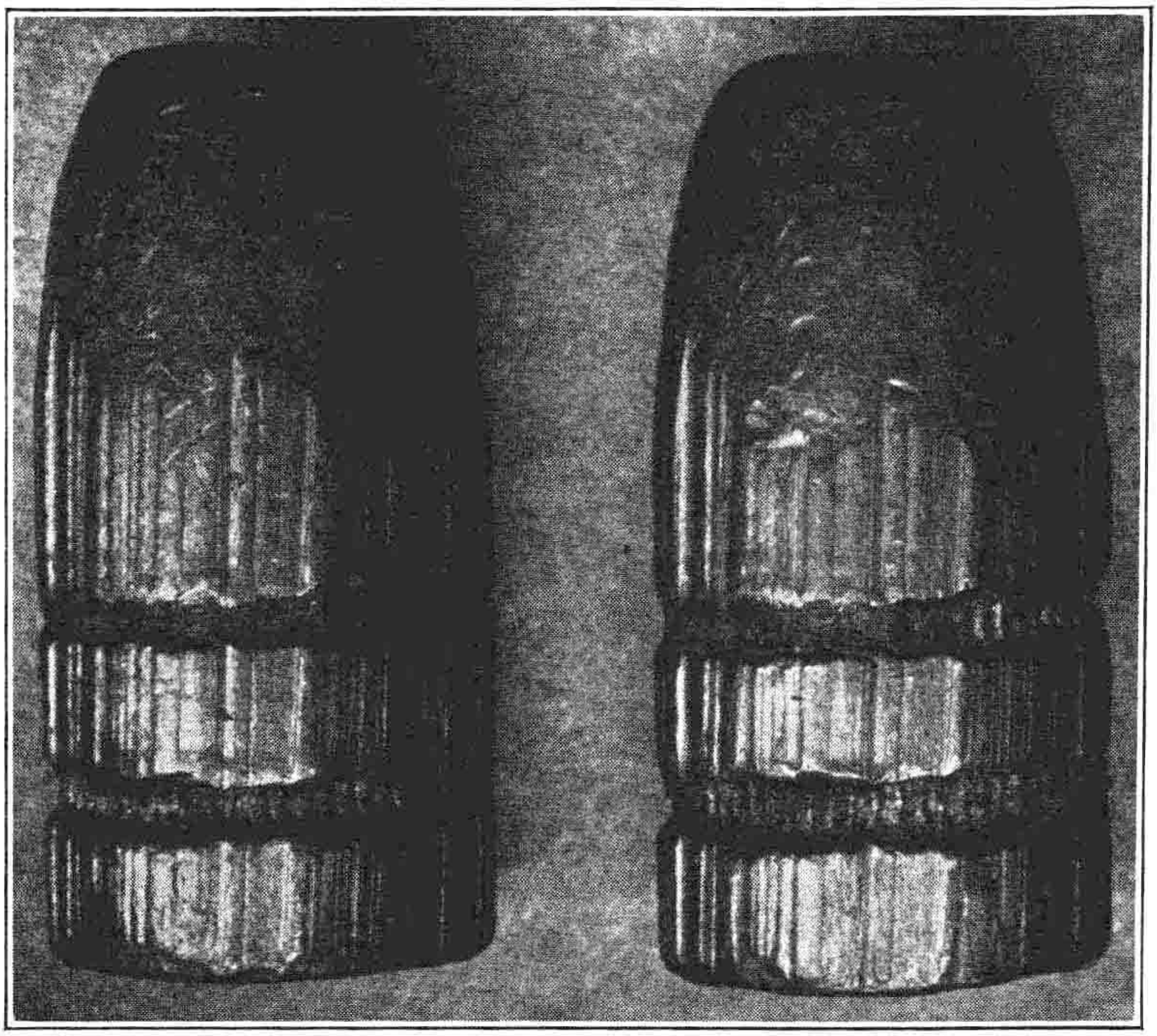
4. A test bullet fired from a murder revolver. The condition shown here is typical of the cheap, poorly constructed, or old and worn low-grade guns which so often figure in homicides. The cylinder lined up very badly, and much shaving of lead from one side of the bullet resulted. Moreover, the barrel is loose, and is so badly fouled and worn that there were absolutely no distinct land or groove marks discernible. Such a gun forms a difficult problem in identification. M—The side of the bullet where the shaving of lead took place on account of failure of the cylinder to line up properly.

all. Cross examination asked whether he had obtained identification on any of the additional bullets. He replied that he had not. Result, acquittal.

No matter how enthusiastic he may be on the advantages of the modern scientific methods of bullet and cartridge case identification, no one who knows the subject will hesitate to admit that cases will arise when these methods will fail as has just been shown; but even when no decision can be reached by the use of the comparison microscope, no harm has been done, while in the vast majority of cases the authorities have the great satisfaction of being able to see definitely for themselves by the aid of the expert, whether the evidence cartridge or bullet did or did not come from the suspected weapon.

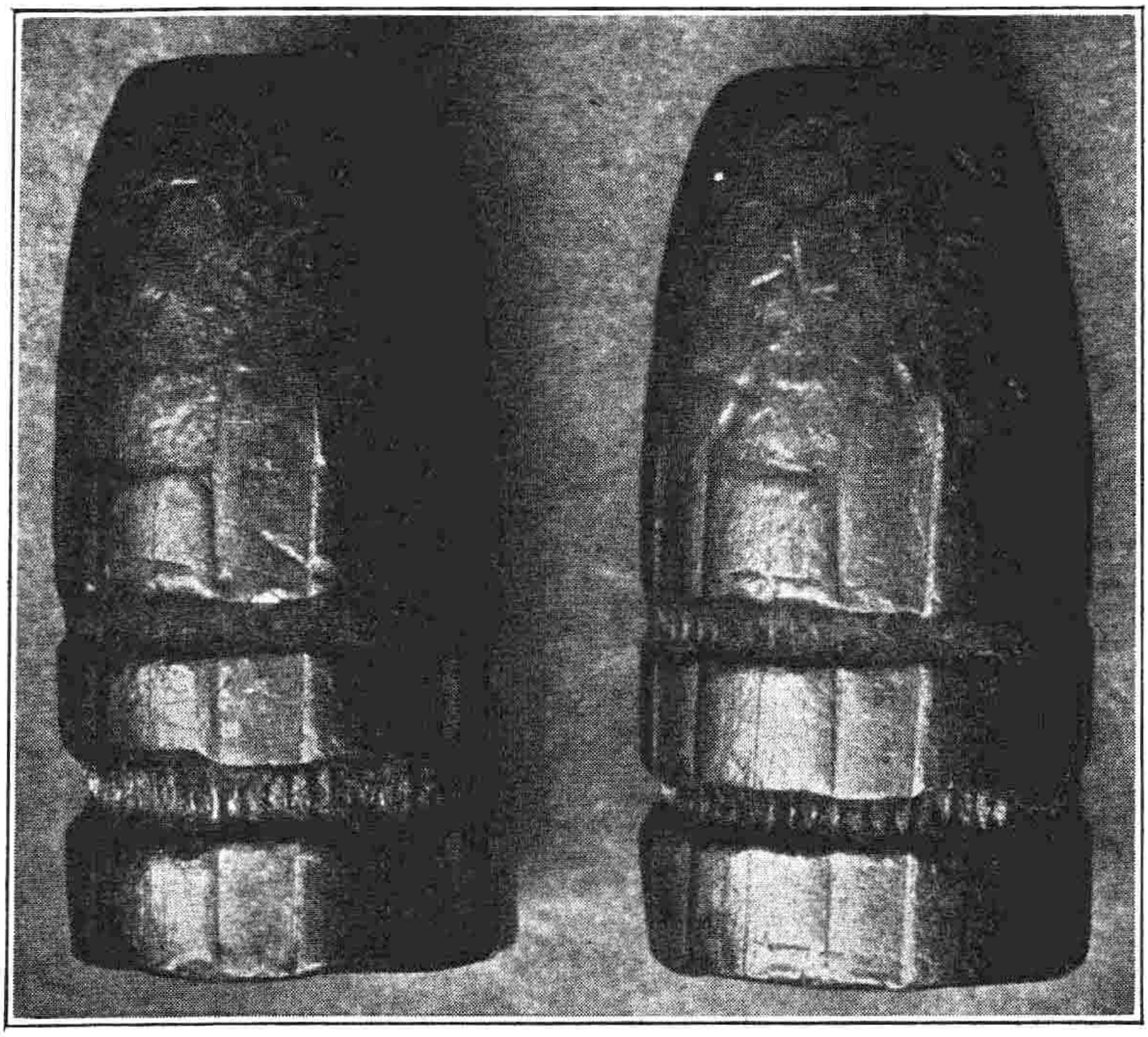
The beauty of this scientific method of identification is that it is unavailable to the unscrupulous so-called expert who will testify for either side and will do his best to color all the evidence in favor of those who are paying his fat fees. The real scientific firearms expert who uses the methods described will stick to *facts* in his testimony, and cross examination will have no terrors for him, for he always has the facts behind his testimony, and he is sure of his ground. Either he did find a definite identification of the bullet and the gun, or he did not. There can be no half-way ground in his testimony.

The fact that "a little knowledge is a dangerous thing" is once more illustrated by the fact that certain very well intentioned individuals recently came very near having a Federal law enacted to require every maker of a pistol or revolver to fire and recover a bullet from each gun made, and to mark that bullet with the number of the gun, and keep it for reference by the legal authorities in case a crime should later be committed with a gun of that caliber. In the first place, it is by no means certain that a bullet fired through the same gun several years later would match the one kept for record, for the barrel may have rusted or otherwise changed during the interval. In the second place, the matter of the classification of bullets so as to lighten the labor of looking for the right one of the thousands of record bullets has not, and probably never can be, solved, for the fine scratches, parallel to the rifling marks, on which this identification depends, have nothing by which they can be sub-classified. It is quite different with finger prints, with their five fingers on each hand, each having different combinations of whorls, loops, and deltas; they can be classified so that the investigator can go directly to one small group and start his search there; but this cannot be done with bullets. They can, of course, be roughly classified by caliber, number of grooves, direction of rifling, etc.; but there is no method of sub-classification. Suppose, for example, that the maker produces only 1000 .38 Special caliber guns in the same year. There will be five or six grooves on each bullet, say 5000 grooves to be compared in trying to match the murder bullet to only one year's production of guns of only one maker. It may take from fifteen minutes to one hour to compare each groove, and looking searchingly into the comparison microscope is impossible for more than about three hours a day, otherwise the



Photograph by the author, showing two bullets fired from the same revolver, the barrel of which was badly rusted. The bullets checked perfectly, but do not show any resemblance to similar bullets fired from the same type gun in new condition. This illustrates the impracticability of the suggestion that the makers of firearms should be required to fire a bullet from each arm made, and keep it for reference in case a crime were committed with the gun. After a year or so of use and abuse, identification would be impossible.

operator is likely to suffer severely from eye-strain, fatigue, and headache. At this rate, it would take one operator something like four or five years to search one manufacturer's record bullets for one year's production of one caliber of gun.



Photograph by the author, showing two bullets from the same .38 caliber revolver. The barrel of this gun was exceptionally smooth, but the bullets checked perfectly in the comparison microscope. Compare this photograph with the following one, which shows two bullets from an exactly similar gun, in which the barrel had been allowed to become badly rusted and fouled.

The greatest difficulty which the real expert has to face today is the confusion and lack of understanding of the whole subject on the part of the courts, the juries, and the public, due to the newness of the subject, and to the slowly fading effects of the old type of so-called experts.

CHAPTER 9

DIGEST OF COURT DECISIONS ON FIREARMS IDENTIFICATIONS

THERE is included here for the use of those members of the legal profession and of law enforcement agencies who may be interested, the following list showing where the reader may find a discussion of several questions concerning Expert Opinion Evidence and other related matters. This list was furnished through the courtesy of Lieut. John H. Fowler, Firearms Identification Expert of the Metropolitan Police, District of Columbia. These references are all to McKelvey on Evidence, Fourth Edition.

Rules regarding the use of expert evidence and the manner of its introduction—p. 244.
Distinction between "Expert Testimony as to Facts" and "Expert Opinion"—p. 247.
Matters forming the subject of expert opinion—p. 253.
Photographs as evidence—p. 441.
Photographic evidence as original evidence—p. 443.
Pictorial evidence, authentication of—p. 444.
Pictorial evidence, materiality of—p. 446.
Pictorial evidence, admissibility as affected by accessibility of thing represented—p. 444.

There is also included for ready reference, the following compilation of the leading court decisions relating to the development and admissibility of evidence based on firearms identification. This material, which was very kindly furnished by the Federal Bureau of Investigation, U. S. Department of Justice, Washington, D. C., is arranged for convenience of reference by states, alphabetically listed, with the latest cases in each placed first.

DEVELOPMENT AND ADMISSIBILITY OF BALLISTICS AND FIREARMS EVIDENCE

This compilation of leading court decisions, dealing with ballistics and firearms evidence, has been prepared by the Bureau of Investigation for the ready reference and assistance of law enforcement agencies.

ALABAMA

(Alabama, 1933)

GRAVETTE v. STATE

147 Southern Reporter 641—decided by the Court of Appeals of Alabama, June 21, 1932. Re-hearing denied February 21, 1933. Petition for certiorari denied by Supreme Court of Alabama, April 19, 1933.

This was a burglary case in the course of which the Sheriff testified that he had found a .38 caliber pistol in the house of the defendant. He stated that he had had considerable experience with firearms and that as Sheriff for over four years he had had occasion to handle firearms during that time and had examined various and different kinds of firearms. He testified that, from his experience in examining firearms, in his opinion the pistol had been recently fired. The Court of Appeals of Alabama held that this evidence was admissible stating:

> "The foregoing testimony by the Sheriff was sufficient predicate for the witness to testify as an expert."

(Alabama, 1931)

HUGHES v. STATE

135 Southern Reporter 310—decided by the Court of Appeals of Alabama, February 24, 1931. Certiorari denied by Supreme Court of Alabama, June 11, 1931 (135 Southern 311).

This case, in which the charge was assault with intent to commit murder, decided in effect that a patrolman, testifying to 20 years experience in handling pistols and affirming his ability to tell when a pistol was "fresh shot" was properly permitted to testify to that effect.

The Alabama Court of Appeals stated:

> "Patrolman Bates, State's witness, stated he had been handling pistols 20 years on the police force; that he could tell by examination when a pistol had been 'fresh shot,' and that within a very few minutes (5 minutes) after the shooting he went to the scene of the shooting with another officer and found defendant at the top of his steps with a pistol in his hand; that he took the pistol and examined it, etc. It was therefore proper for the court to allow this witness to testify that this appellant's pistol at that time contained one empty shell, fresh shot. and four loaded cartridges."

(Alabama, 1922)

PYAES v. STATE

92 Southern Reporter 663, 207 Alabama 413—decided by the Supreme Court of Alabama, February 9, 1932. Re-hearing denied April 27, 1922.

This was a murder case in which the Supreme Court of Alabama stated:

> "A revolver was found near the body of the deceased as it lay in the road. The cartridge in one chamber of the revolver had been discharged. May, a witness for the prosecution, testified that he was familiar with such things, that he had used pistols and shells a good deal and that the shell in the empty chamber and the barrel of the revolver showed that it had not been discharged recently. The relevancy of this testimony is pertinent. Further objection was taken on the ground that the witness was not shown to be expert. A witness may have expert knowledge of some of the more ordinary affairs of life (citing several cases) and our opinion is that this witness was qualified to testify as he did."

(Alabama, **1914)**

WISE v. STATE

66 Southern Reporter 128—decided by the Court of Appeals of Alabama, June 30, 1914.

This was a murder case, reversed and remanded by the Court of Appeals of Alabama. Among other things, it held that two witnesses who had testified in the trial court had not qualified as experts with regard to the weapon alleged to have been used. On this point the Court of Appeals said:

> "The mere fact that the witness Matheny was a physician did not necessarily, of itself, without more, and when it was made to appear that he had had experience, show him to be qualified as an expert to give his opinion of how close the gun was to the deceased, when the shot that caused her death was fired, and the court committed no error in refusing to admit this evidence as competent expert opinion testimony. A witness to testify as an expert must first be shown to be such.
>
> "We hardly think the witness J. F. Johnson was shown to have sufficient knowledge on the subject to answer as an expert to the hypothetical questions that he was permitted to answer against the objection of the defendant. His experience and observation seem principally limited to the modern arms used in warfare, and he was shown to have had but little knowledge, if any, of a weapon like the one with which the deceased was killed—a short, single-barreled shotgun. His opinion must necessarily have been based upon a species of knowledge variant from the facts hypothesized, and consequently variant from the knowledge which the law requires as a qualification of one who gives his opinion as an expert."

(Alabama, 1913)

SMITH v. STATE

62 Southern Reporter 184, 182 Alabama 38—decided by the Supreme Court of Alabama, April 15, 1913.

This was a murder case reversed and remanded by the Supreme Court of Alabama, in which the Supreme Court stated relative to testimony to the effect that wounds had been caused by a bullet of a particular caliber:

> "Any intelligent and mature witness may ordinarily be allowed to state that visible wounds observed by him are gunshot wounds, for the matter is, in general, one of common knowledge, but without the special knowledge of an expert, a witness cannot state that such wounds are made by a bullet of a particular caliber. There was, however, no dispute about the matter of the wounds and the caliber of the bullet, was immaterial, and its improper proof perfectly harmless to defendant."

(Alabama, 1913)

SMITH v. STATE

62 Southern Reporter 575, 8 Alabama Appeals S. 187—decided by the Court of Appeals of Alabama, April 8, 1913.

This was a murder case reversed and remanded by the Court of Appeals of Alabama, which said relative to the evidence of witnesses concerning firearms:

> "The evidence as to the distance the person who did the shooting was standing at the time is conflicting; the state's witness putting it, one, upon estimate, at 40, 50 or 60 yards, and the other at 63 steps, * * * while those of the defendant put it at about 125 yards. We are of the

> opinion that under the facts detailed, it was competent for the defendant to show the carrying distance of a gun of the kind used, its danger zone, and its carrying power, as the gun used was charged and loaded, was insufficient under any circumstances to produce death or serious bodily harm at a distance of 40 yards. The opinions of witnesses as to these matters are competent, provided the witnesses are first shown to be sufficiently qualified by experience and general or special knowledge of the subject to give an opinion."

(Alabama, 1911)

SANDERS v. STATE

56 Southern Reporter 69—decided by the Appellate Court of Alabama, June 30, 1911.

This was a murder case in which the trial court refused to allow certain testimony of a defense witness relative to the distance from which a shotgun had been fired. On this point the Appellate Court said:

> "The witness Saffold did not show himself to be an expert on the subject inquired about. On his knowledge of shotguns he says, 'Have lived in the country most all of my life and have been accustomed to using shotguns all of my life' but he nowhere says that he has, at any period, made the subject inquired about one even of casual study * * *. We seriously doubt whether a man of ordinary observation, accustomed to the use of firearms all his life, with any satisfactory degree of accuracy, can say what space a shotgun which he never saw, and as to the caliber, bore, and length of barrels of which he knew nothing, will cover in a given distance with its shot * * *. The court, therefore, committed no error in refusing to allow the witness to answer the questions."

(Alabama, 1910)

PHILLIPS v. STATE

54 Southern Reporter 111, 170 Alabama 5—decided by the Supreme Court of Alabama, December 22, 1910.

This was an assault with intent to murder case in which the Supreme Court of Alabama held that the testimony of a gun expert as to powder burns, the character of the shells, and the manner in which the shot would scatter within a certain distance, was admissible.

The Supreme Court said:

> "There was a dispute in the evidence as to the distance the defendant was from Melton when he shot him, and the testimony of Dr. Farish, who was a gun expert, as to the powder burns, the character of the shells and the manner in which the shot would scatter within a certain distance, was admissible as evidence for the jury in determining whether or not the defendant was close or some distance off when he fired the shot."

(Alabama, 1896)

EVANS v. STATE

19 Southern Reporter 535, 109 Alabama 11—decided by the Supreme Court of Alabama, February 6, 1896.

This was a manslaughter case, reversed by the Supreme Court of Alabama, which held, among other things, that in a prosecution for homicide, an expert witness cannot testify that, as an experiment, he fired a bullet through a plank, to ascertain the size of the hole made as compared with the bullet.

CALIFORNIA

(California, 1932)

PEOPLE v. BOLTON

8 Pacific Reporter (2d) 814—decided by the Supreme Court of California, February 9, 1932.

This was a murder case in which the defendant objected that the testimony of an expert on interior ballistics, and an authority on pistols, relative to the action of a pistol, was improperly admitted in evidence in the trial court.

Passing on this contention, the Supreme Court of California stated:

> "Neither can we accede to appellant's claim of reversible error in the admission of the testimony of an expert on interior ballistics. It is founded upon the assertion that the manner of action of an automatic pistol may not be shown without some evidence that a weapon of similar type was used in committing the crime. Since it appeared that both the deceased and the defendant were shot by a .25 caliber automatic pistol, this and other facts which we need not repeat rendered the evidence pertinent to a fair consideration of the whole case."

(California, 1931)

PEOPLE v. FARRINGTON

2 Pacific Reporter (2d) 814—decided by the Supreme Court of California, August 25, 1931.

This was a murder case. Just before the close of the trial the defendant, without giving any reason, offered a bullet in evidence which had been taken from the body of the murdered man and was merely marked "for identification." It was admitted. As evidence in the case was being closed, the defendant requested permission to submit the bullet to "some person who was either an expert on ballistics or an expert with the microscope" for the purpose of ascertaining whether the bullet could possibly have been ejected from a pistol having the rifling of the pistol in evidence.

In passing upon the trial court judge's refusal to grant this request, the Supreme Court of California stated:

> "Such requests are addressed to the discretion of the trial judge, and in the absence of a prejudicial refusal, such a denial will not work a reversal on appeal. We have read all the evidence about the pistol and the bullet and cannot see that the denial of appellant's request resulted in any prejudicial or material harm to his case."

(California, 1925)

PEOPLE v. WILLIS

233 Pacific Reporter 812, 70 California Appeals 465—decided by the District Court of Appeals, Second District, Division Two, California, December 31, 1924. Hearing denied by Supreme Court, February 26, 1925.

This was a murder case in which the Court of Appeals of California held that in a murder prosecution, an expert's testimony as to the operation of a gun used by the defendant, and the difficulty of pulling the trigger, while holding it in the position from which the defendant was alleged to have fired, was admissible. On this point the Court of Appeals said:

> "The witness' statement that, holding the gun in a certain position, it was difficult to pull the trigger, is merely a statement of fact, and at the same time an explanation of the mechanical operation of the firearm."

As to the admissibility of the results of experiments with firearms, the court said:

> "Experiments with firearms have frequently been made in homicide cases, and the results proven at the trial as tending to show the guilt or innocence of the accused. Such results are not conclusive, but are competent and admissible, and their weight is for the jury to determine."

(California, 1922)

PEOPLE v. ELLIS

206 Pacific Reporter 753, 188 California 682.

This was a murder case decided by the Supreme Court of California, May 5, 1922, in which the Supreme Court held, among other things, that in a homicide prosecution, testimony of medical experts and firearms experts, that the bullet went into the back and come out through the abdomen of the deceased, was admissible and competent, and its weight and value for the jury to decide.

(California, 1896)

PEOPLE v. CONKLING

44 Pacific Reporter 314, 11 California 616—decided by the Supreme Court of California, March 21, 1896.

This was a murder case, reversed by the Supreme Court of California, which held, among other things, that in a trial for murder the action of certain jurors, in experimenting on their own account with a rifle similar to the one with which the defendant killed the accused, to see how far powder marks would be carried upon clothing by the fire, was ground for reversal.

CONNECTICUT

(Connecticut, 1924)

THE STATE v. HAROLD ISRAEL

Criminal Superior Court, Fairfield County, Connecticut, May 27, 1924. Journal of the American Institute of Criminal Law and Criminology, Volume 15, for November, 1924, page 406, and also Volume 59, of the American Law Review for March-April, 1925, page 161.

This famous case was one in which the Honorable Homer S. Cummings, Attorney General of the United States, as State's Attorney, Stamford, Connecticut (in 1924) recommended a nolle prosequi of charges of murder in the first degree against Israel, largely as a result of his opinion and that of six expert ballisticians that the bullet extracted from the brain of the murdered man had not been fired from the pistol of the accused.

In commenting upon this class of evidence, the Attorney General, who was then State's Attorney of Connecticut, stated:

> "This brings us to a general consideration of that class of expert testimony which deals with the identification of a bullet with a particular weapon where both are available for experimentation. In this case we have the Israel revolver and we have the mortal bullet. Of late years there has grown up a system of examination in such cases which is based upon scientific theories, supplemented by actual experimentation. It has come to be a very definite science. Men qualify themselves by experience in dealing with such matters. Sometimes it is described as the science of 'finger printing bullets.' Of course, it is obvious any bullet discharged through a particular weapon will bear the marks of the weapon through which it has passed, and if the bullet be recovered

> and is in sufficiently good condiion to be examined, it will often bear unmistakable traces of its previous history. Ordinarily, in such cases, witnesses measure the width of what are known as the 'lands' and 'grooves' on the bullet. They then make a cast of a portion of the barrel of the suspected weapon and make duplicate measurements. They then discharge experimental shots through the suspected weapon and recover the bullets thus fired. These bullets are usually fired into soft substances like cotton. The recovered bullets are then measured in the same manner and compared by means of the microscope and enlarged photographs with the suspected bullet. In addition to this, the experimental bullet is inspected for characteristic marks. If any are found these are measured and located. The suspected bullet is then examined for similar marks. Consideration is given to the number and dimensions of lands and grooves, to the direction or twist of the rifling in the barrel and the caliber of the bullet. Consideration is given as to whether the bullet is upset on impact or otherwise disturbed. The weight of the bullet is considered and the question of the presence or absence of what is known as a grease groove.
>
> "These characteristics are searched for. Sometimes one element is missing and others are found to exist. The condition of any bullet under examination is sometimes such that many of these marks of identification are destroyed. It so happens, however, that in a majority of cases where the bullet is recovered and the suspected weapon is available, it is possible for experts to say definitely whether the bullet came out of the suspected weapon or not."

In summing up this phase of the case, Mr. Cummings added:

> "After conferring at length with all of the ballistic engineers and having compared their opinions, I have no hesitancy in accepting the conclusions reached by the six gentlemen to whom I referred. Of course, the acceptance of that conclusion marks an end to the case. In the face of such an opinion it would be preposterous to contemplate a trial, and, moreover it would be an injustice even to longer suspect Israel of murder."

(Connecticut, 1881)

THE STATE v. JAMES SMITH

49 Connecticut 376—decided by the Supreme Court of Errors of Connecticut, at the December term, 1881.

This was a murder case in which the Supreme Court of Connecticut ruled that in considering whether the fatal shot was fired from the prisoner's pistol or from one in the hands of the deceased, both of which were before the trial court as exhibits, it was not error for the trial judge to refuse to allow an expert to take away the pistols for the purpose of experimenting with them with a view to ascertaining from which the bullet came, since this was a matter wholly within the discretion of the trial court.

District of Columbia

(District of Columbia, 1927)

LANEY v. UNITED STATES

294 Federal Reporter 412, 54 Appeals D. C. 56—decided by the Court of Appeals of the District of Columbia, December 3, 1923. Re-hearing denied December 21, 1923.

This was a manslaughter case in which the Court of Appeals of the District of Columbia decided, among other things, that expert testimony to the effect that the bullet extracted from the decedent's head was shot from the pistol found in defendant's possession, was competent. On this point the Court said:

> "Likewise the testimony given by the expert witness, tending to establish that the bullet extracted from the head of the deceased, was shot from the pistol found in the defendant's possession, was competent, and the examination in this particular was conducted without prejudicial error, especially when taken in connection with the testimony of defendant wherein he admitted the firing of a number of shots at the crowd assembled in the street."

GEORGIA

(Georgia, 1914)

BYRD v. STATE

83 South Eastern Reporter 513, 142 Georgia 633, L.R.A. 1915—B-1143—decided by the Supreme Court of Georgia, November 11, 1914.

This was a murder case in which the Supreme Court of Georgia held that it was competent for a witness who testified that he had experience in firing shells of a given description and had observed the impression made upon objects when struck by shots fired from shells of that character, and he had also examined and probed the wound of the person alleged to have been murdered, to state as his opinion that the wound upon the deceased was made by the discharge of a "cut" or "rung" shell.

(Georgia, 1876)

MOUGHTON v. STATE OF GEORGIA

57 Georgia 102—decided by the Supreme Court of Georgia, July term, 1876.

This was an assault with intent to murder case (reversed on other grounds) in which the Supreme Court of Georgia held that the opinion of a witness experienced in the use of guns as to the length of time since a gun was fired, is admissible evidence in connection with the facts on which it is founded, and that the shot found the next day after the shooting in one barrel of the prisoner's gun, the other being empty, had been compared with those lodged in and about the person of the deceased, were like them, was admissible evidence.

IDAHO

(Idaho, 1894)

STATE v. HENDEL

35 Pacific Reporter 836—decided by the Supreme Court of Idaho, February 19, 1894.

This was a murder in the second degree case in which the Supreme Court of Idaho held, among other things, that where counsel for the defendant requested that a chemical and microscopic examination of a bullet should be made to determine if there was evidence of human blood or tissues on the bullet, and it appeared that such a test would consume from one to two weeks, the denial of the request by the trial court was not error, there being no evidence of anything upon the surface of the bullet that seemed to indicate the presence of the suggested particles.

The Supreme Court of Idaho also held the admission or rejection of expert testimony (in this case whether a certain bullet which had cloth markings on it had passed through the body of the defendant), rests largely in the sound discretion of the trial court and should be admitted, if such testimony would tend to aid the jury in coming to a satisfactory conclusion, and that the admission of such testimony in this case was not in error.

ILLINOIS

(Illinois, 1930)

PEOPLE v. FISHER

172 North Eastern Reporter 743, 340 Illinois 216—decided by the Supreme Court of Illinois, June 20, 1930.

This was a murder case in which the Supreme Court of Illinois held that one qualified as an expert ballistician could testify and demonstrate his reasons for stating that a bullet removed from the deceased's body had been fired from a certain pistol, and that shotgun wads removed from the deceased's body had been fired from certain exploded shotgun shells and from a certain shotgun rather than from certain other shotguns.

This case is one of the most comprehensive reported cases dealing with ballistics and the admissibility of ballistics evidence.

(Illinois, 1923)

PEOPLE v. BERKMAN

139 North Eastern Reporter 91, 307 Illinois 492—decided by the Supreme Court of Illinois, 1923.

This was an assault with intent to murder case which was reversed and remanded by the Supreme Court of Illinois, which held that where one month after the alleged shooting, a revolver was found near the place where guards of another railroad yard had found the defendant after shooting and pursuing him from the yards, evidence of an officer whom the prosecution had attempted to qualify as an expert, that the bullet extracted from the victim was one fired from the revolver found as stated above, was clearly absurd. The court said in part:

> "If it were possible in this case to determine whether or not the bullet was fired from the gun in question, it must have been by the peculiar rifling or condition of the gun that made what are called the peculiar markings on the bullet aforesaid.
>
> "If any facts pertaining to the gun and its rifling existed by which such fact could be known, it would have been proper for the witness to have stated such fact and let the jury draw their own conclusions."

IOWA

(Iowa, 1931)

STATE v. CAMPBELL

239 North Western 715—decided by the Supreme Court of Iowa, December 16, 1931.

This was a manslaughter case in which the Supreme Court of Iowa held that a witness who had served as an ordnance officer in the army, and who had made a special study of small arms and ammunition for years, and possessed suitable instruments to make proper tests, was competent to testify as a ballistics expert.

The court also held that one so qualified as a ballistics expert could testify as to his conclusion that two bullets had passed through the same barrel, and that he could use pictures of the bullets, not taken by him but taken and developed under his direction, after he had set the bullets in position to be photographed.

This case also gives a comprehensive description of ballistics evidence and its admissibility.

KANSAS

(Kansas, 1911)

STATE v. NORDMARK

114 Pacific 1068, 84 Kansas 628—decided by the Supreme Court of Kansas, April 8, 1911.

This was a murder case in which the Supreme Court of Kansas held, among other things, that a person who has acquired special knowledge and skill as to the use of firearms, and by experience, observation and practice had learned the effect of shots and bullets cutting through limbs or shrubs, is competent to testify whether a certain shrub or limb was cut by a buckshot and also whether certain empty shotgun shells had been loaded with large or small shot.

(Kansas, 1896)

STATE v. ASBELL

46 Pacific Reporter 770, 57 Kansas 398—decided by the Supreme Court of Kansas, November, 1896.

This was a murder case in which the Supreme Court of Kansas held, among other things, that a witness experienced in the use of firearms, who had conducted experiments by shooting at human hair and a paper target, with the pistol with which the deceased was killed, and using cartridges similar to those found in the pistol, at a distance ranging from six inches to ten inches, was properly permitted by the trial court to testify as to the effects resulting from the shooting upon the hair and also as to powder burns and marks.

(Kansas, 1889)

STATE v. JONES

21 Pacific Reporter 266, 41 Kansas 309—decided by the Superеme Court of Kansas, April 5, 1889.

This was a murder case which was reversed and remanded by the Supreme Court of Kansas, and in which the Supreme Court held, among other things, that a witness who was produced by the defendant at the trial, and who testified that he had been a gunsmith for thirty years, and had experimented for years to ascertain how far guns and muskets would carry shot compactly, and that he was able to state how far from the musket used, a person receiving such a wound as deceased would have been, was qualified as an expert and should have been allowed to give the evidence sought which was both competent and material.

KENTUCKY

(Kentucky, 1929)

EVANS v. COMMONWEALTH

19 South Western (2d) 1091, 230 Kentucky 411—decided by the Court of Appeals of Kentucky, May 31, 1929, as modified on Denial of Re-hearing, September 27, 1929.

This was a manslaughter case in which the Court of Appeals of Kentucky held, among other things, that a witness qualified as a firearms expert could illustrate by blackboard drawings that tool marks on different pistols were so different as to permit identification of bullets fired from the respective weapons.

The Court also held that such a firearms expert could demonstrate his ability to identify bullets fired from each of two pistols, in rebutting testimony of two other witnesses, who introduced bullelts fired from certain pistols, and that permitting the jury to examine the bullets so identified under the microscope to see distinguishing marks for themselves, was not erroneous or prejudicial.

The Court also held that the evidence of a firearms expert identifying bullets as fired from the pistol of the accused was properly admitted and was not of such a highly technical, unreasonable and extremely doubtful nature as to make it admissible.

This case gives a comprehensive discussion as to the admissibility and development of ballistics evidence.

(Kentucky, 1928)

LAWSON v. COMMONWEALTH

1 South Western (2d) 1060, 222 Kentucky 614—decided by the Court of Appeals of Kentucky, January 17, 1928.

This was a murder case in which the Court of Appeals of Kentucky held that the trial court was not required to order the sheriff introducing the pistol of the defendant so as to show whether shells coming therefrom were dented as were shells found near the scene of the homicide, although permission to have experiments made could be given to the defendant.

(Kentucky, 1928)

JACK v. COMMONWEALTH

1 South Western (2d) 961, 222 Kentucky 546—decided by the Court of Appeals of Kentucky, January 10, 1928.

This was a murder case, reversed and remanded by the Court of Appeals of Kentucky, which held that a former deputy sheriff-jailer and a jailer were not competent to testify that their tests and examination of the barrel of the pistol in evidence, the fatal bullet and cartridges procured from the pistol by them, made with an ordinary magnifying glass, showed that the bullet was fired from such pistol and corresponded with the cartridges so obtained, because the question was such a technical one that these witnesses were not qualified to give opinions without special study and suitable instruments and equipment for tests.

The Court also held in this case that such pertinent facts developed by the examination of non-expert witnesses on the technical subject of the identity of fatal bullet with that fired from the pistol in evidence, as are susceptible of demonstration before the jury, are competent, though the witnesses' conclusions are inadmissible.

It should be noted that the Court of Appeals of Kentucky held in the instant case that the admission of the two above named witnesses' testimony to the effect that ordinary magnifying glass tests showed that the fatal bullet was fired from the pistol in evidence, was prejudicial error and ground for reversal.

(Kentucky, 1899)

FRANKLIN v. COMMONWEALTH

48 South Western Reporter 986, 105 Kentucky 237, 20 Kentucky Law Reports 1137—decided by the Court of Appeals of Kentucky, January 10, 1899.

This was a murder case reversed by the Court of Appeals of Kentucky, in which this court held that witnesses introduced by defendant, who had several years experience with firearms, were qualified as experts and should have been allowed to testify as to the kind of gun by which a wound was inflicted, and to give evidence that in their judgment the wound could not have been caused by the gun of the accused.

LOUISIANA

(Louisiana, 1932)

STATE v. VOORHIES

141 Southern Reporter 859, 174 Louisiana 860—decided by the Supreme Court of Louisiana, April 25, 1932.

This was a murder case in which the Supreme Court of Louisiana held that the opinion of a coroner, who was a doctor, but not an expert on ballistics, as to the direction of a bullet after it passed through the deceased's body, was admissible, as was also his testimony relative to the direction the deceased was looking when the bullet which passed through his head was fired.

(Louisiana, 1905)

STATE v. VOORHIES

38 Southern Reporter 964, 115 Louisiana 200—decided by the Supreme Court of Louisiana, June 19, 1905.

This was a murder case in which the Supreme Court of Louisiana held that a coroner who had been sworn as an expert physician and surgeon, and who had examined the wounds of the deceased, might give his opinion as to the kind of weapon used and the distance from which the shot was fired.

MARYLAND

(Maryland, 1919)

NEWKIRK v. STATE

106 Atlantic Reporter 694, 134 Maryland 310—decided by the Court of Appeals of Maryland, April 8, 1919.

This was a murder in the second degree case in which the Court of Appeals of Maryland held that the knowledge a witness must possess before being entitled to give his opinion as an expert is largely within the discretion of the trial court, and that in this case the trial court had properly admitted testimony as to experiments made by a doctor, with the pistol with which the decedent had been shot to determine from what distance the weapon had been fired to cause the marks found upon the decedent and her clothes.

MASSACHUSETTS

(Massachusetts, 1933)

COMMONWEALTH v. SNYDER, et al.

185 North Eastern 376—decided by the Supreme Judicial Court of Massachusetts, April 7, 1933.

This was a murder case in which the Supreme Judicial Court of Massachusetts held that it was not error on the part of the trial court to permit a firearms expert to testify as to the approximate direction and position of the deceased at the time of the shooting and to permit such expert to testify as to the effect of powder marks for the purpose of determining the distance at which the pistol was held from the deceased's body, where he had made experiments under conditions similar to those existing at the time of the homicide.

(Massachusetts, 1928)

COMMONWEALTH v. GLEASON

159 North Eastern 518—decided by the Supreme Judicial Court of Massachusetts, January 10, 1928.

This was a murder case in which the Supreme Judicial Court of Massachusetts held that a question to a firearms expert as to whether his predecessor in the same position which he held was also a pistol expert, was properly excluded by the trial court as being of no probative value and having no bearing on the qualifications of the witness as an expert on the facts in issue.

(Massachusetts, 1902)

COMMONWEALTH v. BEST

62 North Eastern 748, 180 Massachusetts 492—decided by the Supreme Judicial Court of Massachusetts, February 27, 1902.

This was a murder case in which the Supreme Judicial Court of Massachusetts held that the trial court properly admitted testimony introduced by the State as to a bullet forced through the barrel of a certain rifle bearing rust marks, very similar to marks on two bullets found in the deceased's body, and that pictures of all three bullets could be introduced to establish this contention.

The Court held also that expert testimony was admissible to show that bullets found in the deceased's body were marked by rust in the same manner as if fired through a certain rifle, and that it took several months for the rust in the rifle to form.

MICHIGAN

(Michigan, 1878)

BROWNELL v. PEOPLE

38 Michigan Reports 732—decided by the Supreme Court of Michigan, June 4, 1878.

This was a murder in the second degree case in which the Supreme Court of Michigan held that the trial court properly excluded the testimony of a certain individual upon the grounds that he was not an expert on pistol shots. The Supreme Court said on this point:

> "It appears to us that the testimony of one called as an expert upon the effect of a pistol shot upon the clothing when fired at a certain distance, was based on too small an experience. A single pistol shot through his own clothing, without proof of the comparative amounts or kinds of loading, and without ever seeing whether experiments at greater or less distances, or at the same distance, with pistols of the same or different make or calibre, is too small a foundation for generalizing."

MISSISSIPPI

(Mississippi, 1893)

FOSTER v. STATE

12 Southern Reporter 822, 70 Mississippi 755—decided by the Supreme Court of Mississippi, April 17, 1893.

This was a murder case, reversed by the Supreme Court of Mississippi, in which the Supreme Court held that it was error to permit a doctor to give opinions as to the range of the bullet which passed through the deceased's head, or as to the position of decedent's hand and arm when he was shot in the arm and body, where these opinions were formed from other proven facts, since it was for the jury to draw their own conclusions from these proven facts.

MISSOURI

(Missouri, 1922)

STATE v. HARLEN

240 South Western Reporter 197—decided by the Supreme Court of Missouri, April 10, 1922.

This was a murder in the second degree case in which the Supreme Court of Missouri held that testimony as to how far a certain gun would eject a shell was not "experimental testimony," and that such testimony was proper testimony for a duly qualified expert.

MONTANA

(Montana, 1921)

STATE v. BESS

199 Pacific Reporter 426, 60 Montana 558—decided by the Supreme Court of Montana, July 2, 1921.

This was a murder case in which the Supreme Court of Montana held that it was not error for the trial court to permit an ex-soldier and a hunter, both of whom qualified as experts in the use of the rifle to the satisfaction of the trial court, to testify for the State as to the effect produced by hard-nosed and soft-nosed bullets, to rebut the testimony introduced by the defendant, that the death of the deceased was caused by a hard-nosed bullet, which the defendant swore he had never used or possessed.

NEW JERSEY

(New Jersey, 1932)

STATE v. BASSONE

160 Atlantic Reporter 391, 109 New Jersey Law 176—decided by the Court of Errors and Appeals of New Jersey, May 16, 1932.

This was a murder in the second degree case in which the court of Errors and Appeals of New Jersey held that the trial court was right in refusing to give the defendant's charge, that the testimony of a ballistics expert was not evidence of facts testified to apart from opinion evidence.

OHIO

(Ohio, 1930)

BURCHETT v. STATE

172 North Eastern Reporter 555, 35 Ohio Appeals 463—decided by the Court of Appeals of Ohio, May 9, 1930.

This was a murder in the second degree case in which the Court of Appeals of Ohio held that evidence that a particular bullet came from a particular gun based upon a comparison of rifling testified to by an expert was admissible, and that whether a witness was qualified and sufficiently educated and experienced to testify as an "expert" on this matter, was a matter for the trial court to decide.

This case gives a good outline of the progress made in ballistics as a science.

OKLAHOMA

(Oklahoma, 1932)

QUINN v. STATE

16 Pacific Reporter (2d) 391—decided by Criminal Court of Appeals of Oklahoma, November 29, 1932.

This was a murder case reversed and remanded by the Criminal Court of Appeals of Oklahoma, in which the court held that it was error for the trial court to refuse to permit a witness to make ballistic and similar tests before the jury to determine whether a certain bullet had been fired from a certain gun.

(Oklahoma, 1918)

COLLINS v. STATE

175 Pacific Reporter 124, 15 Oklahoma Criminal Reports 96—decided by the Criminal Court of Appeals of Oklahoma, Ocotber 7, 1918.

This was a murder case in which the Criminal Court of Appeals of Oklahoma held that the subject of firearms and the size of bullets shot by different kinds of pistols was a proper subject upon which to permit a qualified person to express an opinion, where such opinion was material to the issues involved in the trial (i. e. whether a certain bullet had been fired from a .38 or a .41 caliber pistol), and that such evidence had been properly admitted by the trial court.

OREGON

(Oregon, 1923)

STATE v. CASEY

213 Pacific Reporter 771, 108 Oregon 386—decided by the Supreme Court of Oregon, March 20, 1923.

This was a murder case in which the Supreme Court of Oregon held that evidence by a pistol expert that bullets found in the deceased's body had been fired from a Colt's Army special revolver, such as the defendant possessed, was competent and properly admitted by the trial court.

The Supreme Court said on this point:

> "Robert H. Craddock, a well known pistol expert, qualified as such, and testified at the trial. * * * By comparing the rifling marks on the test bullets with the rifling marks appearing on the two leaden balls that were found in and on the body of Phillips, the deceased, the expert was qualified to testify that in his opinion, the bullets removed from the body of the dead man had each been fired from a Colt's Army special revolver. The testimony was competent. Its weight was exclusively for the jury."

RHODE ISLAND

(Rhode Island, 1903)

STATE v. NAGLE

54 Atlantic Reporter 1063, 25 Rhode Island 105, 105 American State Reports 864—decided by the Supreme Court of Rhode Island, April 15, 1903.

This was a murder case in which a petition for a new trial was granted by the Supreme Court of Rhode Island. The court held that an expert on gunshot wounds who had testified as to experiments he had made with a .32 caliber revolver to determine the nature of the powder burns produced by them, and also as to experiments with the particular revolver alleged to have been used by the defendant, was properly admitted as expert evidence by the trial court.

SOUTH CAROLINA

(South Carolina, 1899)

STATE v. DAVIS

33 South Eastern Reporter 449, 55 South Carolina 339—decided by the Supreme Court of South Carolina, June 22, 1899.

This was a murder case in which the Supreme Court of South Carolina held that the testimony of witnesses accustomed to the use of firearms, and who had observed the appearance presented by a gun recently fired, were competent to testify that a gun and empty shell found near the body of the deceased did not present the appearance of having been recently fired, and that their testimony was properly admitted in evidence by the trial court.

The Supreme Court held further in this case that non-expert witnesses are competent to testify that a gun and empty shell found near the body of the deceased had been recently fired, where they stated the facts on which they based their opinions.

TEXAS

(Texas, 1932)

KENT v. STATE

50 South Western Reporter (2d) 817—decided by the Court of Criminal Appeals of Texas, May 4, 1932. Re-hearing denied, June 15, 1932.

This was a murder case in which the Court of Criminal Appeals of Texas held that the testimony of an expert witness regarding an experiment made in the defendant's absence with a gun found in the defendant's possession, was properly admitted by the trial court, as was the expert witness' statement that a shell found near the deceased's body and one found in the gun in the defendant's possession, were the same in every respect, upon the ground that this was simply the opinion of the expert that the two shells were alike.

The Court held further in this case that the expert witness' testimony to the effect that he had been employed by the sheriff to make certain experiments with the gun found in the defendant's possession after the homicide, was properly admitted by the trial court.

(Texas, 1914)

HOLDEN v. STATE

194 South Western Reporter 162, 81 Texas Criminal Reports 194—decided by the Court of Criminal Appeals of Texas, March 21, 1917, and motion for re-hearing, April 18, 1917 overruled.

This was a manslaughter case in which the Court of Criminal Appeals of Texas held that the testimony of a deputy sheriff, fully qualified as an expert on pistols, that a pistol exhibited at the trial and shown to have been in the deceased's possession at the time of the killing, had in his opinion been fired only once, was properly admitted by the trial court, and that the determination of whether the deputy sheriff was competent to testify as an expert on this matter was largely a question for the trial court's discretion.

The Court also ruled in this case that the trial court had not abused its discretion in refusing to admit the testimony of a witness who had never seen the pistol involved until put on the stand, and who said that he knew about as much about such matters as the average man who uses a gun, to testify as an expert, as to how many times the pistol had been fired.

(Texas, 1911)

STREIGHT v. STATE

138 South Western Reporter 742, 62 Texas Criminal Reports 453—decided by the Court of Criminal Appeals of Texas, April 19, 1911. Motion to reform judgment denied, May 24, 1911.

This was a murder case, reversed and remanded by the Court of Criminal Appeals of Texas, in which the court held that the trial court was in error in refusing to permit a witness for the defendant who had qualified as a firearms expert to testify that he had made certain experiments and tests on dummies having eyebrows of human hair, lying in the same position that the deceased was supposed to have lain at the time he was killed, using a pistol of the same caliber and cartridges of the same make as the defendant was supposed to have used, and that it would be impossible at any range for the powder to burn off an eyebrow of the deceased under such circumstances.

(Texas, 1903)

BEARDEN v. STATE

73 South Western Reporter 17, 44 Texas Criminal Reports 578—decided by the Court of Criminal Appeals of Texas, March 18, 1903.

This was a murder case in which the Court of Criminal Appeals of Texas held that the trial court had properly admitted expert testimony to show to what extent shot from a muzzle-loading shotgun will scatter at various distances, and that a witness had properly qualified to testify as to the distance at which decedent had been fired on by a muzzle-loading shotgun, judging from the extent the shot had scattered, by virtue of having testified that he used his father's muzzzle-loading shotgun and had owned one of his own for five years and shot at trees to determine its range.

(Texas, 1903)

MEYERS v. THE STATE

14 Texas Court of Appeals Reports 35—decided by the Court of Appeals of Texas, April 18, 1903.

This was an assault with intent to murder case in which the Court of Appeals of Texas held that the trial court had properly permitted witnesses who were proven to be experienced in the use and handling of firearms to testify that they tested the condition of the gun of the defendant by putting their fingers in the muzzle shortly after the alleged offense, and that, in their opinion, it had been recently discharged.

WASHINGTON

(Washington, 1928)

STATE v. GRUBER

272 Pacific Reporter 89, 151 Washington 66—decided by the Supreme Court of Washington, November 30, 1928.

This was a murder in the second degree case in which the Supreme Court of Washington held that the trial court had properly admitted the testimony ot a witness who had made a special study of such matters to testify as to the distance from which shots fired from a revolver would make such wounds and marks as were found on the deceased's body and clothing, based on experiments subsequently made by the witness with the revolver that was used to commit the crime, and made under substantially the same circumstances.

WISCONSIN

(Wisconsin, 1908)

POLLOCK v. STATE

116 North Western Reporter 851, 136 Wisconsin 136—decided by the Supreme Court of Wisconsin, June 5, 1908.

This was a manslaughter case in which the Supreme Court of Wisconsin held that the trial court had properly permitted the State in rebutting the defendant's testimony to the effect that the fatal shot was fired at very close range, after testimony that there were no powder marks on the body of the deceased, to show by experiments made by an expert shooting the same pistol and using similar cartridges, and firing through the vest worn by the deceased at various distances from two inches to four feet, that powder stains were made on the vest when firing from a distance of two inches or eight inches.

The Court also held that the State was properly permitted by the trial court to show, by expert testimony, that there would have been powder stains on the body of the deceased if the pistol had been fired at a distance of six inches.

UNITED STATES

(United States, 1896)

UNITED STATES v. BALL

163 United States 662, 16 Supreme Court Reports 1192, 41 Law Edition 300—decided by the Circuit Court of Appeals of the United States for the Eastern District of Texas, May 25, 1896.

This was a murder case, reversed as to Ball, in which the Circuit Court of Appeals of the United States for the Eastern District of Texas, held that it was within the discretion of the trial court to decline to permit a gun found in the defendant's possession, to be taken out and shot in the presence of a deputy marshal to test how the gun "bunched" or "scattered" buckshot, although there was conflicting evidence as to how the gun would scatter buckshot, and upheld the trial court in its refusal to order such a test.

CHAPTER 10

THE BIBLIOGRAPHY OF FIREARMS IDENTIFICATION AND ALLIED SUBJECTS

AMERICAN

The Missile and the Weapon,
A. L. Hall, M. D.
Buffalo Medical Journal, Buffalo, June, 1900.
(Reprinted in the July-August, 1931, issue of the *American Journal of Police Science*)

Study of Fired Bullets and Shells in Brownsville, Texas, Riot.
Annual Report of Chief of Ordnance, U. S. Army, Government Printing Office, Washington, 1907, Pages 35 and 36.

Evidence in Shooting Cases.
Col. Calvin H. Goddard.
Chicago Police Journal, November, 1913.

Dispersion of Bullet Energy in relation to Wound Effects.
Colonel Louis B. Wilson, Med. Res.
The Military Surgeon, Washington, Sept. 1921.

"Fingerprints" on Bullets.
C. G. Williams.
Outdoor Life, Denver, Colorado, May, 1922.

Ballistic Jurisprudence.
R. E. Herrick.
Arms and The Man, Washington, May 15, 1923.

Optics and the Detective.
Bausch and Lomb Magazine,
Rochester, New York, July, 1925.

The Silent Witness Speaks.
Major Walcott LeClear Beard.
Police Magazine, New York, July, 1925.

Science vs. Crime.
Major Walcott LeClear Beard.
True Police Stories, New York, December, 1925.

Fingerprinting Bullets, The Silent Witness.
Wesley W. Stout.
Saturday Evening Post, Philadelphia, June 13 & 20, 1925.

Forensic Ballistics.
Major C. H. Goddard.
Army Ordnance, Washington November-December, 1925.

Sherlock Holmes Outdone.
George C. Henderson.
Ambition, Scranton, Pennsylvania, Vol. 20, No. 2, February, 1925.

The Finger Prints of a Bullet.
The Literary Digest, New York, July, 1926.

Science Turns Detective.
E. C. Crossman.
Scientific American, New York, January, 1926.

A New Way of Examining the Inside of a Rifle Barrel.
Scientific American, New York, April, 1926.

Bullets as Evidence in Shooting Cases. Important Considerations Relative to Their Removal and Preservation.
Calvin H. Goddard.
New York State Journal of Medicine, New York, Aug. 15, 1926.

Tracking the Killer by His Bullets.
No Author's Name.
Popular Science Monthly, New York, January, 1926.

Identifying the Criminal's Gun (Editorial).
Journal of the American Medical Association, Chicago, March 20, 1926.

Photographing the Bore of a Rifle.
I. C. Gardner.
The Military Engineer, Washington, November-December, 1926.

Bullet Identification.
William J. Crawford.
The Edison Monthly, New York City, May, 1926.

The Identification of Projectiles in Criminal Cases.
Major Calvin H. Goddard.
The Military Surgeon, Washington, February, 1926.

Scientific Identification of Firearms and Bullets.
Calvin H. Goddard.
Journal of Criminal Law and Criminology, Chicago, August, 1926.

Detective Ballistics.
Major J. S. Hatcher.
Pages 131-133 of Book *"Pistols and Revolvers"* published by Small Arms Technical Publishing Co., Marines, Onslow Co., N. C., 1927.

Who did the Shooting?
Calvin H. Goddard.
Popular Science Monthly, New York, Nov. 1927.

"Forensic" or Legal Ballistics, In *Pistol and Revolver Shooting.*
By A. L. A. Himmelwright.
Published by The MacMillan Company, New York, 1928.

Death by Gunshot—Scientific Methods of Differentiating Between Suicide, Accident, and Foul Play.
Calvin H. Goddard.
The Spectator, New York, August 30, 1928.

The Scientific Detective Story.
E. C. Crossman.
In *Forest and Stream,* January, 1929.

Ballistics a New Science.
Don Sullington.
The Criminologist, Chicago, June, 1929.

Identification of Typewriters and Guns by Precision Methods of Comparison and Measurement.
Wilmer Souder.
Technical News Bulletin, No. 147, Bureau of Standards, Washington, July, 1929.

Forensic Ballistics.
Major Calvin H. Goddard.
Medical Times, New York, July, 1929.

How the St. Louis Ballistics Expert Operates in His Part of Crime Detection. (Newspaper.)
St. Louis Globe-Democrat, St. Louis, July 14, 1929.

Forensic Ballistics—Popular Style.
Lt. Col. Calvin H. Goddard.
The American Rifleman, Washington, July, 1929.

Little Black Bag to Solve Crimes.
H. C. Davis.
Popular Science Monthly, New York, August, 1929.

Ballistics Forensically Applied.
H. E. Cassidy.
Journal of Criminal Law and Criminology, Chicago, Nov., 1929.

Forensic Ballistics. (Pamphlet.)
H. N. Bundesen and John Drury.
Chicago Daily News (Pamphlet), 1929.

Microscope and Camera in the Detection of Crime.
P. O. Gravelle.
Journal Photomicrographic Soc. 15:244, 1930.

Gang Guns.
Lt. Col. Calvin Goddard.
The American Rifleman, Washington, January, 1930.

The Valentine Day Massacre: A Study in Ammunition Tracing.
Calvin H. Goddard.
The American Journal of Police Science, Chicago, Jan.-Feb., 1930.
(Reprinted in *Archiv fur Kriminologie,* #88.)

Unmasking the Pseudo-Expert.
Emory Smith.
The American Journal of Police Science, Chicago, Jan.-Feb., 1930.

Markings on Bullets and Shells Fired from Small Arms.
Charles O. Gunther.
Mechanical Engineering, Easton, Pa., Feb. & Dec., 1930.

The Science of Ballistics: Judicial Applications.
Joseph T. Buxton, Jr.
Law Notes, Northport, L. I., New York, May, 1930.

Some Questions Not in the Program.
E. C. Crossman.
The American Journal of Police Science, Chicago, May-June, 1930.

The Scientific Side of Firearms and Crime.
E. C. Crossman.
The Sporting Goods Dealer, St. Louis, June, 1930.

Is There a "Perfect" Crime?
John F. Coggswell.
Popular Mechanics, Pages 194-199, Vol. 54. Aug., 1930.

Scientific Criminology.
Stanley F. Gorman.
Scientific American, New York, October, 1930.

Ballistics as Applied to Police Science.
Capt. Seth Wiard.
The American Journal of Police Science, Nov.-Dec., 1930.

Military Firearms Adapted by Criminals to Suit Their Purposes.
N. Suskin, Kief, U. S. S. R.
Translation reprinted in *The American Journal of Police Science,* Chicago, Nov.-Dec., 1930.

Medico-Legal Significance of the Scientific Crime Detection Laboratory of Northwestern University.
Lt. Col. Calvin Goddard.
The Military Surgeon, Washington, December, 1930.

Firearms as Evidence.
Calvin H. Goddard.
The American Journal of Police Science, Chicago, Jan.-Feb., 1931.

Evidence—Homicide—Identification of Bullet and Firearm.
John H. Wigmore.
Illinois Law Review, Chicago, February, 1931.

The Admissibility of Ballistics in Evidence.
Joseph E. Serhant.
American Journal of Police Science, Chicago, May-June, 1931.

Now Real Detectives Beat Sherlock Holmes.
Edwin W. Teale.
Popular Science Monthly, New York, August, 1931.

A Camera for Photographing Bullets.
Inst. World, Page 84, August, 1931.

An Optical Method for Determination of the Velocity of Rifle Bullets and Gun Shot.
J. Taylor and R. Wark.
Journal of Scientific Inst., Page 288, September, 1931.

Winchester's Ballistic Chief Has Helped to Unravel Many Crime Mysteries.
C. S. Landis.
The Sporting Goods Dealer, St. Louis, Mo., Nov., 1931.

Hidden Crime Clues Bared by Chemists' Magic.
Edwin W. Teale.
Popular Science Monthly, New York, November, 1931.

The Schopflin Case.
Ed Tangen.
The American Journal of Police Science, Chicago, Nov.-Dec., 1931.

Ballistics.
Harry J. Myers.
Finger Print Magazine, Chicago, January, 1932.

The Literature of Gunshot Injuries (A Bibliography).
Allen P. Wescott.
American Journal of Police Science, Chicago, Jan.-Feb., 1932.

The Preliminary Identification of Fired Bullets.
Seth Wiard.
American Journal of Police Science, Chicago, Jan.-Feb., 1932.

Secrets of Crime Read on Bullets.
Edwin W. Teale.
Popular Science Monthly, New York, Feb., 1932.

Science Trails the Criminal.
Albert A. Hopkins.
Scientific American, New York, Feb., 1932.

Modern Methods of Firearm Identification.
Calvin H. Goddard.
The South Dakota Peace Officer, March, 1932. (Published at Sioux Falls, South Dakota.)

Firearm Identification.
Wilmer Souder.
Army & Navy Journal, Washington, March 19, 1932.

Principles of Firearms Identification.
Charles O. Gunther.
Army Ordnance, Washington, March-April, 1932.

How Science Solves Crime: 11. Identification of Firearms.
Calvin Goddard.
Hygeia, Chicago, March, 1932.

Determination of the Type of Pistol by an examination of Fired Bullets and Shells.
Dr. Otto Mezger, Dr. Walter Heess, and Criminal Inspector Fritz Hasslacher.
Translated from the German and reprinted in the *American Journal of Police Science.*

Bullet Identification Data, in *The Sporting Goods Dealer* (St. Louis, Mo.), March, 1932.
Part 1, Nov.-Dec. 1931. Part II, Mar.-April, 1932.

Probabilities and Effects in Forensic Ballistics.
Spencer B. Moxley.
Printed in the Proceedings of the 17th Annual Convention, California State Division, Int. Association for Identification, Pages 55-59, Tulare, Calif., April 6-9, 1932.

Evidence—Expert Testimony—Ballistics. (Colorado.)
Joseph Gray.
Under "Recent Criminal Cases" in the *Journal of Criminal Law and Criminology,* Vol. XXIII, No. 1, May-June, 1932.

Precision Measurements in Firearm Identification.
Wilmer Souder.
Commercial Standards Monthly (Bureau of Standards Publication) Vol. 9, No. 3, Pages 59-61, Washington, September, 1932.

Powder Marks in Homicide Cases.
Calvin H. Goddard.
Hygeia, October, 1932.

Ballistics and the Law.
Chapter 17 of *The Book of the Springfield.*
Capt. E. C. Crossman.
Published by Small Arms Technical Publishing Co., Marines, Onslow County, North Carolina, 1932.

Identification of firearms in Criminal Cases.
Major J. S. Hatcher.
Part I—Army Ordnance, July-August, 1933. Part II—Army Ordnance, September-October, 1933.

A Camera for Bullet Photography.
C. A. Peterson.
Chicago Police Journal, May, 1934.

A National Firearms Bureau.
Lt. Col. Calvin H. Goddard.
Chicago Police Journal, July, 1934.

Proof Tests and Proof Marks.
Lt. Col. Calvin H. Goddard.
Part I, *Army Ordnance,* November-December, 1933. Part II, *Army*

Ordnance, January-February, 1934. Part III, *Army Ordnance,* March-April, 1934. Part IV, *Army Ordnance,* May-June, 1934. Part V, *Army Ordnance,* July-August, 1934.

A Bullet Classification Formula?
Roy Frisen, with editorial comment by Col. Goddard.
Chicago Police Journal, September, 1934.

A Criminologist to the Rescue. (Article about Goddard.)
N. O'Leary.
Literary Digest, October 6, 1934.

Determining the Origin of Wounds.
C. T. Symonds.
Chicago Police Journal, October, 1934.

In Search of the Firearm.
Col. Calvin H. Goddard.
Chicago Police Journal. Part I, January, 1935. Part II, February, 1935.

ENGLISH

The Examination of Firearms and Projectiles in Forensic Cases.
A. Lucas, O. B. E., F. I. C.
The Analyst, London, July, 1923.

What the Bullet Tells.
Hugh Pollard.
Discovery, London, November, 1924.

The Identification of Firearms and Projectiles.
Sidney Smith, M. D., D. P. H.
British Medical Journal, London, Jan. 2, 1926.

A Bullet's "Fingerprints."
The Graphic, London, October 15, 1927.

Microscopic Revolver Tests as Used in the Essex Murder Case.
The Illustrated London News, London, October 8, 1927.

The Identification of Firearms and Projectiles.
Sidney Smith.
The Police Journal, London, July, 1928.

The Forensic Examination of Firearms and Projectiles.
Robert Churchill.
The Police Journal, London, July, 1929.

The Bullet and the Microscope.
Lt. Col. Calvin H. Goddard, U. S. A.
The Rifleman, London, November, 1929.

Injuries from Firearms.
Sidney Smith.
Police Journal, London, July, 1930.

Identification of Firearms.
Sydney Smith and John Glaister.
Recent Advances in Forensic Medicine, London, 1931.

Examination of Firearms and Ammunition.
Major Robert Churchill.
Transactions of the Medico-Legal Society for the Session 1930-1931 (Vol. XXV). Published by W. Heffer & Sons, Ltd., Cambridge, 1932.

Identification of Firearms and Forensic Ballistics.
Major Gerald Burrard, D.S.A., R.F.A., (Retired). Cloth, 220 pages. Herbert Jenkins, Ltd., London, 1934. Price, 12/6.

FRENCH

Les Plaies par Armes à Feu Courtes (Thesis) (Wounds by Small Arms) Noilles, Paris, 1857.

Études Médico-Légales des Plaies d'Entrée par Coups de Revolver. Poix. (Medico-Legal Study of Wounds of Entry Caused by Revolver Bullets). *Traivail du Laboratoire de Médicine-Légale de Lyon,* 1885.

La Détermination de la Distance à Laquelle un Coup de Feu a été Tiré. (Determination of the Distance at Which a Shot has been Discharged from a Firearm). Corin, ————, 1898.

Études Médico-Légales sur les Armes à feu Courtes. (Thesis) (Medico-Legal Studies on Small Firearms). Girard, Nancy. 1906.

Identification des Projectiles de Revolver en Plomb nu.
(Identification of Revolver Projectiles of Plain Lead). V. Balthazard. *Comptes Rendus de l'Academie des Sciences,* Vol. 148, Page 188. Paris, 1909.

Les Empreintes des Vêtements sur les Balles en Plomb.
(Imprints of Clothing upon Lead Bullets). Genonceux. *Archives Internationales de Médicine-Légale,* Paris, 1912.

Ulidon. Homicides et Suicides. (Thesis)
(Homicides and Suicides). Nancy, 1912.

Identification des Projectiles d'Armes à Feu.
(Identification of Projectiles from Firearms). V. Balthazard. *Archives d'Anthropologie.* Lyon. May 20, 1912.

Expertises sur des Balles et des Douilles dans l'Assassinat au Bureau de Postes de Besons.
(Studies of Bullets and Shells in the Assassination at the Post Office in Besons). Grivolat. St. Etienne, 1913.

Leclercq, Guenez, et Noailles, "Les Pistolets Automatiques au Point de Vue Médico-Légal."
(Automatic Pistols from the Medico-Legal Point of View). *Annales d'Hygiene Publique et de Médicine-Légale,* 1913, p. 151.

Identification des Douilles de Pistolets Automatiques.
(Identification of Shells from Automatic Pistols). V. Balthazard. *Archives d'Anthropologie Criminelle et de Médicine Lègale.* Lyon December 15, 1913.

Récherches sur l'Identification des Projectiles.
(Studies on the Identification of Projectiles). Cr. G. Corin et le Commandant d'Artillerie Genonceaux. *Archives Internationales de Médicine Légale,* Paris, 1914.

Les Balles Explosives Autrichiennes.
(Austrian Explosive Bullets). Reiss. Lausanne, 1915.

Identification des Armes à feu et des Chapitre IV, L'Expertise des Plaies Par Armes à Feu.
Dr. P. Chavigny. Paris, 1918.

Notions de Balistique Populaire. VII L'expertisé en matière de tir.
(Popular Ballistic. Note—Part VII. The expert in shooting cases.) *Pierre Medinger.* Luxembourg, 1919.

Comment Les Experts Identifient Les Balles Des Assassins.
Jacques Boyer. In *La Nature,* No. 2519. July 15, 1022. Reprinted in *Revista de Medicina Legal de Cuba,* Havana, January, 1931.

Identification des Projectiles. Perfectionnement de la Technique.
(Identification of Projectiles. Perfection of the Technique). V. Balthazard. *Annales de Médicine Légale,* Vol. 2, Pages 345-350. Paris, 1922.

Une Nouvelle Méthode pour Déterminer l'Identité des Projectiles.
(A New Method to Determine the Identity of Projectiles). Georgiades. *Annales de Médicine Légale,* Vol. 2, Pages 30-32. Paris, January, 1922.

Communication sur l'Identification des Douilles et des Projectiles tirés.
(Communication upon the Identification of Fired Shells and Bullets). De Rechter et Mage. *Annales de Médicine Légales,* Paris, 1923.

Manuel de Technique Policière.
(*Les Armes et les Explosifs.* Chapter VIII, Pages 228-238). Locard, Paris, 1923.

Identification des Douilles et des Projectiles Tirés.
(Identification of Fired Shells and Projectiles). De Rechter et Mage. Extrait de la *Revue de Droit Pénale,* Bruxelles, Feb., 1925.

Identification des Douilles et des Projectiles Tirés.
(Identification of Fired Shells and Projectiles). Lt. Col. J. Mage. *Revue de Droit Pénal et de Criminologie,* Bruxelles, February, 1925.

Le Transport des Débris de Vètements par les Projectiles et leur Pénétration dans la Peau.
(The Carrying Away of Clothing Debris by Projectiles and Their Penetration into the Skin). Piédelièvre. *Societé de Médicine Légale,* Paris, 1926.

Débris de Vêtements dans les Plaies par les Armes à Feu. (Thesis).
(Debris of Clothing in Wounds Made by Firearms). Sarrante. Paris, 1926.

Un Nouveau Procédé d'Identification des Projectiles.
(A New Process for the Identification of Projectiles). Cordonnier. *Annales de Médicine Légale,* No. 10, Preis, 1926.

Note sur la Pression Nécessaire à la Formation des Empreintes d'étoffes sur les Balles de Plomb Nu.
(Note on the Pressure Necessary for the Formation of Imprints of Fabrics on Plain Lead Bullets). Pièdelièvre. *Societé de Médicine Légale,* May, 1927.

Les Empreintes des Vêtements Relevées sur les Balles de Plomb.
(Imprints of Clothing Transferred to Lead Bullets). Pièdelièvre. *Etude Criminologiques,* No. 3, April, 1927.

Consideration sur une Méthode d'Identification des Objets. Son Application à un cas Particulier.
(Consideration of a Method for Identifying Objects. Its Application to a Particular Case). De Rechter et Mage. Extrait de la *Revue de Droit Pénal,* Bruxelles, May, 1927.

L'Execution de Sacco et Vanzetti.
L'Illustration, Paris, August 27, 1927.

L'Identification des Balles avec l'Arme.
Chapter IV of *L'Expertise des Armes à Feu Courtes.* Harry Söderman. Lyon, 1928.

Identification des Armes, des Projectiles et des Poudres.
Chapter III of *Expertise en Armes à Feu.* Wilfrid Derome, Montreal, 1929.

Medico-Legal Study of Residue in Barrels of Firearms.
R. Pièdelièvre and C. Simonin. *Annales de Médicine Légale,* Paris, October, 1929.

Méthode Improvisée pour l'Identification Photographique des Projectiles et des Douilles de Revolver.
(An Improvised Method for Identifying Photographically Projectiles and Shells from Revolvers). Dr. J. Maingard. *Annales de Médicine Légale,* Paris, November, 1931.

Les Projectiles des Armes de Guerre.
(Projectiles of Military Arms). Nimier et Laval.

Etude Chimique des Poudres.
(Chemical Studies of Powders). Balthazard et Garnier. *Societé de Médicine Légale,* Paris.

GERMAN

Zur Sachverständigen Beurteilung von Geschossen.
(The Expert Examination of Fired Bullets). Kockel. *Kriminalfällen,* Leipsig, 1905.

Bestimmung der Identität und Herkunft einer Kugel.
(Determination of the Identity and Origin of a Bullet). Hulst. *Archives für Kriminologie,* Berlin, 1923.

Zur Identifiziergun Abgeschossener Patronenhülsen.
(The Identification of Empty Fired Cartridge Cases). Dr. F. Pietrusky. *Archiv für Kriminologie,* p. 95, Berlin, May, 1925.

Beiträge aus Untersuchung und Beurteilung von Geschossen, Waffen und Einschüssen.
(Contributions upon the Study and Examination of Fired Bullets, Weapons, and Gunshot Wounds). Prof. Dr. A. Brüning. *Archiv für Kriminologie,* Page 81, Berlin, May, 1925.

Die Kriminaltechnische Untersuchung von Patronenhülsen und Geschossen.
(Technical Studies of Empty Shells and Projectiles in Criminal Shooting Cases). Dr. G. Raestrup. *Deutsche Zeitschrift für die gesamte Gerichtliche Medizin,* Vol. 7, Pages 242-259, Berlin, 1926.

Schiesstechnische Untersuchungen.
(Technical Investigations in Shooting Cases). Dr. Otto Mezger. *Zeitschrift für Untersuchung der Lebensmittel,* Vol. 52, Nos. 1 and 2, Berlin, 1926.

Mord durch Pistolenschuss.
(Death From a Pistol Shot). Dr. Raestrup. *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin,* Vol. 14, Pages 62-71, Berlin, 1929.

Zur Identifiziergun der Selbstladepistolen.
(The Identification of Self Loading Pistols). Dr. S. N. Matwejeff. *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin,* Vol. 13, Page 461, Berlin, 1929.

Uber die Entwickelung Schiesstechnischer Untersuchungen in Dienste der Justiz.
(The Development of Technical Studies of Shooting Cases in the Service of Justice). *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin,* Vol. 13, Page 377, Berlin, 1929.

Eine neue Photographische Darstellung des Geschossmantels.
(A New Photographic Presentation of a Bullet Jacket). Prof. Dr. A. Prüning. *Archiv für Kriminologie,* Vol. 88, Page 116, Leipsig, 1931.

Ein Apparat zur Untersuchung abgefeuerter Geschosse.
(An Apparatus for the Study of Fired Bullets). Prof. Dr. F. Pietrusky. *Deutsche Zeitschrift für die gerichtliche und Soziale Medizin,* Berlin, Vol. 18, Nos. 2 and 3, 1931.

Kritisches zur gerichtlichen Schussuntersuchung.
(A Critique of Legal Studies in Shooting Cases). Dr. B. Kraft. *Archiv für Kriminologie,* Leipsig, Vol. 87. (Reprinted in *American Journal of Police Science,* Jan.-Feb., 1931).

Uber die Zentralisierung der gerichtlichen Waffenidentifizierung.
(A Central Registry Office for Forensic Firearms Identification). Dr. B. Kraft. *Archiv für Kriminologie,* Leipsig. (Reprinted in *American Journal of Police Science,* May-June, 1931).

Hilfsapparaturen für die gerchtliche Schubuntersuchung.
(Apparatus Used in Forensic Ballistics). Dr. B. Kraft. *Archiv für Kriminologie,* Leipsig, Vol. 88, Page 211. (Reprinted in *American Journal of Police Science,* Sept.-Oct., 1931).

Die Bestimmung des Pistolensystems aus verfeuerten Hülsen und Geschossen.
(Determination of the Type of Pistol Employed from an Examination of Fired Bullets and Shells). Dr. Otto Mezger, Dr. Walter Heess, and Criminal Inspector Fritz Hasslacher. *Archiv für Kriminologie,* Leipsig, Vol. 89. (Reprinted in *American Journal of Police Science,* Nov.-Dec., 1931).

Uber die Entwickelung Schiesstechnischer Untersuchungen im Dienste des Justiz.
(On the Development of Technical Investigations in Shooting Cases in the Service of Justice). Dr. Otto Mezger. *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin,* Berlin, Vol. 13, Pages 377-391.

Spektrographische Untersuchungen von Geschossen des Faustfeuerwaffen.
(Spectrographic Examinations of Projectiles from Hand Firearms). Dr. W. Schwarzocher. *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin, Berlin.* Vol. 13, Pages 226-231.

Zur Identifizierung der Selbstladepistolen.
(On the Identification of Self Loading Pistols). Dr. S. N. Matwejeff. *Deutsche Zeitschrift für die Gesamte Gerichtliche Medizin,* Berlin, Vol. 13, Pages 461-469.

OTHER FOREIGN LANGUAGES

Instruccao de Tiro da Forge Publica do Estado de São Paulo.
(Shooting Instructions for the Public of the State of São Paulo). São Paulo, 1913.

Heridas por Proyectil de Armas de Fuego Portatiles Cortas.
(Wounds by Projectiles from Small Portable Firearms). Dr. Antonio Barreras Y Fernandez. *Revista Médica Cubana,* Havana, 1918.

Problemas Medico-Legales,
Part III of *Heridas por Proyectil de Armas de Fuego Portatiles Cortas.* Dr. Antonio Barreras Y Fernandez. Havana, 1918.

Dissertação do Valor da Estriação dos Projecties na Identificação das Armas de Fogo Curtas.
(Dissertation concerning the Value of Striations on Projectiles for the Identification of Short Firearms). Francisco Antonio Dell'Api. São Paulo, 1919.

Sobre a identificação das capsulas nas pistolas automaticas de repetição.
(Identification of Empty Shells from Automatic Pistols). Urbano Silveira. These, São Paulo, Brasil, 1920.

Valor da Estração Lateral dos Projectis na Determinação das Armas.
(The Value of Lateral Striations on Projectiles in the Identification of Firearms). F. A. Dell'Api. (Thesis). São Paulo, Brasil, 1919.

Da Diagnose da Distancia nos Tiros de Projecties Multiplos (Chumbo de Caça).
(Concerning the Estimation of the Distance from which Multiple Projectiles were Discharged). Dr. Jorge Tibirica Filho. São Paulo, 1921.

Orificio de Entrada de Projecteis de Revolver. (Estudo experimental das zonas de contorno nos tiros proximos).
(The Wounds of Entrance made by Revolver Bullets—An experimental study of the zones produced by shots at close range.) These, São Paulo, Brasil, 1921.

Lesoes por armas de fogo. Diagnose differencial entre os orificios de entrada e de sahica dos projecties.
Wounds by Firearms. Differential diagnosis Between Wounds of Entrance and Exit of Projectiles). These, São Paulo, Brasil, 1922.

Determinação da Data do Uso de uma Arma de Fogo e da Munição.
Gastão Fluery Selveira. São Paulo, 1926.

Contribuição ao estudo das polvoras e modo de as identificar.
(Contribution on the Study of Powders and Methods of Identifying Them). These, São Paulo, Brasil, 1926.

Lesoes por arma de fogo. A zona de contusao e enxugo no orificio de sahida dos projecteis.
Honorato Faustino de Oliveira Junior. These, São Paulo, Brasil, 1927.

Vapenexpertiser in Svensk Polistidning.
(Expert Arms Studies in the Swedish Police Service). Söderman. *Brottels Värld,* Stockholm, Nov.-Dec., 1927.

Busca de los Proyectiles en el Curso de los Autopsias Médico-Légales.
Dr. Chavigny. *Revista de Medicina Legal de Cuba,* Havana, Nov., 1928. (Reprinted from *Annales de Medicine Legale de Criminologie et de Police Scientifique,* Paris).

Un Neuvo Proceder de Identificacion de los Proyectiles.
(A New Procedure for the Identification of Projectiles). Dr. Cordonnier. *Revista de Medicina Legal de Cuba,* Havana, February, 1929. (Reprinted from *Annales de Medicine Legale de Criminologie et de Police, Scientifique,* Paris).

Practica Medico-Forense.
(Forensic Medical Practice). *Revista de Medicina Legale de Cuba,* Havana, Aug., 1930.

Como Identificacan los Expertas las Belas de los Asesinos.
(How Experts Identify Assassins' Bullets). Jacques Boyer. *Revista de Medicina Legas de Cuba,* Havana, January, 1931.

Contribuição Para o Estudo da Identificação Chimica das Polvoras Queimadas.
(Contribution upon the Study and Chemical Identification of Different Powders). Dr. Luis De Assis Pacheco Borta. (Thesis). São Paulo, Brasil.

CHAPTER 11

CONVERSION FACTORS FOR METRIC AND ENGLISH WEIGHTS AND MEASURES USED IN BALLISTICS

In all English speaking countries ballistic measurements of length are made in feet, inches and yards, and measurements of weight are made in grains, pounds and tons. All other countries use the Metric System, and in foreign works on ballistics measurements of length are made in millimeters, centimeters and meters, and weights are measured in grams and kilograms.

The measurements most frequently used in ballistics are the following:

Ranges, given in yards (yds.) or meters (m).

Bullet velocities, given in feet per second (f.s.) or meters per second (m.s.).

The caliber or diameter of guns or bullets, given in hundredths of an inch or in millimeters (mm.).

The weights of bullets, given in grains (gr.) or in grams (g.).

Weights of powder charges, given in grains (gr.), drams (dr.), or in grams (g.).

Powder pressures, given in pounds per square inch (lb. sq. in.), tons per square inch (ton sq. in.), kilograms per square centimeter (kg. cm. sq.), or in atmospheres. (The pressure of the earth's atmosphere is 14.7 pounds per square inch, hence, for example, a pressure of 1,000 atmospheres would be 14,700 pounds.)

The kinetic energy of bullets, given in foot pounds (ft. lb.) or in kilogram meters (kg. meter).

Group diameters, given in inches or in centimeters.

Cartridge case capacities, given in cubic inches (cu. in.) or in cubic centimeters (c. c.).

Units of Length

In the British System the fundamental unit of length is the foot. The other units with their abbreviations and their relation to each other are shown in the table:

12 inches (in.) = 1 foot (ft.)
36 inches = 3 feet = 1 yard (yd.)
5280 feet = 1760 yards = 1 mile (mi.)

In the Metric System the fundamental unit is the Meter which is nearly 1.1 yards. The other related units are as shown below:

10 millimeters (mm.) = 1 centimeter (cm.)
1000 millimeters = 100 centimeters = 1 meter (m.)
1000 meters = 1 kilometer (km.)

The relation of the two systems to each other is as follows:

1 inch = .0254 m. = 2.54 cm. = 25.4 mm.
1 foot = .3048 m. = 30.48 cm. = 304.8 mm.
1 yard = .9144 m. = 91.44 cm.
1 mile—1.6093 km. = 1609.3 m.
1 square inch = 6.45 sq. cm. = 645.2 sq. mm.
1 square foot = .0929 sq. m. = 929. sq. cm.
1 cubic inch = 16.387 c.c.
1 mm. = .03937 in.
1 cm. = .3937 in. = .0328 foot
1 meter = 39.37 in. = 3.2808 feet = 1.0936 yds.
1 kilometer = 3280.8 feet = 1093.6 yds. = .6214 mile
1 sq. cm. = .155729 sq. in.
1 sq. meter = 10.764 sq. ft.
1 cu. cm. = .061024 cu. in.

To convert

Inches to Millimeters multiply by	25.4	or divide by	.03937
Inches to Centimeters multiply by	2.54	or divide by	.3937
Feet to Centimeters multiply by	30.48	or divide by	.0328
Feet to Meters multiply by	.3048	or divide by	3.2808
Yards to Meters multiply by	.9144	or divide by	1.0936
Miles to Kilometers multiply by	1.609	or divide by	.6214

To convert

Millimeters to Inches multiply by	.03937	or divide by	25.4
Centimeters to Inches multiply by	.3937	or divide by	2.54
Centimeters to Feet multiply by	.0328	or divide by	30.48
Meters to Feet multiply by	3.2808	or divide by	.3048
Meters to Yards multiply by	1.0936	or divide by	.9144
Kilometers to Miles multiply by	.6214	or divide by	1.609

Approximate rules, which are close enough for all practical purposes, though not strictly accurate:

To convert Inches to Millimeters, approximately, multiply by 100 and divide by 4. Thus, .32 caliber would equal 8 mm. (Actual value, 8.1 mm.).

To convert Millimeters to Inches, approximately, divide by 100 and multiply by 4. Thus 8 mm. would equal .32 caliber. (Actual value, .325).

To convert Inches to Centimeters, approximately, multiply by 10 and divide by 4.

To convert Centimeters to Inches, approximately, divide by 10 and multiply by 4.

To convert Meters to Feet, approximately, divide by 3 and multiply by 10. Thus, a range of 300 meters would equal 1,000 feet. (Actually 984 feet).

To convert Feet to Meters, approximately, multiply by 3 and divide by 10. Thus a range of 1,000 feet would equal 300 meters. (Actually 304.8 meters).

To convert Yards to Meters, approximately, subtract 1/10. Thus 1,000 yards would equal 900 meters. (Actually 914 meters).

To convert Meters to Yards, approximately, add 1/10. Thus 1,000 meters would equal 1,100 yards. (Actually 1,094 yards).

To convert Miles to Kilometers, approximately, divide by 5 and multiply by 8. Thus 100 miles would equal 160 km. (Actually 160.9 km.).

To convert Kilometers to Miles, approximately, take 5/8 the number of kilometers. Thus 100 km. would equal 62.5 miles. (Actually 62.14 miles).

Units of Weight

In the British system the pound is the basic unit, with other units as given in the tables below. Unfortunately there is a chance for confusion as there are three different kinds of pound: the avoirdupois pound of 16 ounces, used for weighing ordinary merchandise; the troy pound of 12 ounces, used for weighing gold and silver; and the apothecaries' pound of 12 ounces, used for weighing drugs and medicines.

For large weights, the ton is the unit, but there are two kinds of ton: the long ton, of 2,240 lbs., and the short ton of 2,000 lbs.

The Pound Avoirdupois is composed of 7,000 grains, while the Pound Troy and the Pound Apothecaries' have 5,760 grains each. The grain is the same in all three systems.

In ballistics, the long ton of 2,240 lbs. and the avoirdupois pound of 7,000 grains are used. Fortunately the ballistician seldom or never has to use the Pound Troy or the Pound Apothecaries' but they are included in the tables below in order that the difference between the three kinds of pound may be thoroughly understood.

Avoirdupois Weight

27.34375 grains (gr.) = 1 drachm (or dram) (dr.)
16 drams or 437.5 gr. = 1 ounce (oz.)
16 ounces or 7,000 gr. = 1 pound (lb.)
14 pounds = 1 stone
2 stone or 28 lbs. = 1 quarter (qr.)
4 quarters or 112 lbs. = 1 hundredweight (cwt.)
20 hundredweight or 2,240 lbs. = 1 ton (long ton) (gross ton)
2,000 pounds = 1 short ton (net ton)

Note—The stone and quarter are commonly used in Great Britain but not in America.

Troy Weight

24 grains = 1 pennyweight (dwt.)
20 pennyweight or 480 gr. = 1 ounce (oz.)
12 ounces or 5,760 grains = 1 pound (lb.)

Apothecaries' Weight

20 grains = 1 scruple (℈)
3 scruples or 60 grains = 1 drachm (ʒ)
8 drachms or 480 grains = 1 ounce (℥)
12 ounces or 5760 grains = 1 pound (lb.)

In the Metric System the fundamental unit of weight is the gramme (or gram) which is the weight of a cubic centimeter of distilled water at zero degrees Centigrade in a vacuum, or 15.43 grains. The other units are shown in the table.

1,000 Milligrams (mg.) = 1 gram (g.)
1,000 Grams = 1 kilogram (kg.) (or kilo)
1,000 Kilograms = 1 tonne or Metric ton

The pressure of the earth's atmosphere, 14.7 lbs. per sq. in., is often used in ballistics as a unit of pressure under the designation of atmosphere (atm.). In the Metric System, the unit of pressure is one kilogram per square centimeter or 14.223 lbs. per square inch and this is sometimes called a "Technical Atmosphere" and abbreviated as (at.).

In the following comparative tables long tons of 2,240 lbs. and avoirdupois pounds, ounces and drams are meant unless otherwise stated.

1 grain = 64.9 milligrams = .0649 gram
1 dram = 1770 “ = 1.77 “
1 ounce =28350 “ = 28.35 “
1 pound = **453.59** “ = .453 kilo
1 ton = 1016. “ = 1.016 tonne
1 short ton = 907 “ = .907 “

1 milligram = .0154 grain
1 gram = 15.432 “ = .0353 oz.
1 kilo = 15430. “ = 35.3 “ = 2.2046 lbs.
1 tonne = 2204.6 “ = .9842 ton
1 tonne = 2204.6 “ = 1.023 short ton

1 lb. per sq. in. = .0703 kg. per sq. cm.
1 ton per sq. in. = 157.49 kg. per sq. cm.
1 foot-pound = .1382 kg.-meter
1 foot-ton = 309.7 kg.-meter = .3097 meter-tonne
1 atmosphere (atm) (14.7 lb./sq. in.) = 1.033 technical atmosphere (at)

1 kg. per sq. cm. (at) = 14.223 lbs. per sq. in. = .00635 ton/sq. in. = .967 atm.
1 kg.-meter = 7.234 ft.-lbs.
1 meter-tonne = 3.229 ft.-tons

To convert Grains	to Milligrams	multiply by	64.9	or divide by	.0154
“ “ Grains	“ Grams	“ “	.0649	“ “ “	15.43
“ “ Ounces	“ Grams	“ “	28.35	“ “ “	.0353
“ “ Pounds	“ Kilograms	“ “	.453	“ “ “	2.205
“ “ Tons	“ “	“ “	1016.	“ “ “	.000984
“ “ Short Tons	“ “	“ “	907	“ “ “	.001023
To convert Milligrams	to Grains	“ “	.0154	“ “ “	64.9
“ “ Grams	“ “	“ “	15.43	“ “ “	.0649
“ “ Kilograms	“ Pounds	“ “	2.205	“ “ “	.453
“ “ Tonnes	“ Tons	“ “	.9842	“ “ “	1.016
“ “ Tonnes	“ Short Tons	“ “	1.023	“ “ “	**.907**
To convert Feet per Second	to Meters per Second	multiply by	.3048	or div. by	3.28
“ “ Foot Pounds	“ Kilogram meters	“ “	.1382	“ “ “	7.234
“ “ Lbs./Sq. In.	“ Kgs./Sq. Cm.	“ “	14.223	“ “ “	.0703
To convert Meters per Second	**to Feet per** Second	“ “	**3.28**	or div. by	.3048
“ “ Kilogram Meters	“ Foot Pounds	“ “	7.234	“ “ “	.1382
“ “ Kgs./Sq. Cm.	“ Lbs./Sq. In.	“ “	.0703	“ “ “	14.223

Liquid Measure

While liquid measure is rarely, if ever, used in ballistics, the following information is included in order to give the reader a more complete understanding of the relations between the English and the Metric Systems.

The English Imperial Gallon is the volume of ten pounds of distilled water at 62° F. It contains 277.27 cubic inches or 4.5436 liters and is equal to very nearly 1.2 U. S. Gallons. The U. S. Gallon contains 231 cubic inches or 3.7853 liters. It is almost exactly equal to the contents of a cylinder seven inches in diameter and six inches high.

1 gallon = 4 quarts = 8 pints
1 quart = 2 "
1 cubic foot = 7.48 U. S. gallons

The Metric unit is the liter (or litre) which is a volume of 1,000 cubic centimeters. It is equal to 61.024 cubic inches.

1 liter = 2.1134 U. S. pints = 1.0567 quarts = .26417 U. S. gallon

1 U. S. gallon = 3.7853 liters
1 " " quart = .9463 "
1 " " pint = .4731 "

To convert quarts to liters multiply by .9463 or divide by 1.0567
" " gallons " " " " 3.7853 " " " .26417

To convert liters to quarts multiply by 1.0567 or divide by .9436
" " " " gallons " " .26417 " " " 3.7853

PRINCIPAL DIMENSIONS OF VARIOUS MAKES OF PISTOLS AND REVOLVERS

Note—Unless otherwise stated, all dimensions are in inches. Pitch of rifling is in inches per turn. Where two figures are given, the first is the minimum and the second is the maximum. Where only one figure is given it is the average or mean dimension.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
	LUGER AUTOMATIC PISTOLS							
7.65 MM(.30 Cal.)	Luger Automatic Pistol	9.84 R.H.	4	.301	.114	.309	.117	.004
9 MM	Luger Automatic Pistol	9.84 R.H.	6	.348	.087	.354	.098	.003
	MAUSER AUTOMATIC PISTOLS							
7.63 MM(.30 Cal.)	Military Model	7.875 R.H.	6	.300	.043	.309	.110	.0047
7.65 MM (.32 A.C.P.)	Pocket Model	7.875 R.H.	6	.302	.045	.309	.110	.0033
6.35 MM (.25 A.C.P.)	Pocket Model	7.875 R.H.	6	.244	.049	.250	.0787	.003
	REMINGTON ARMS CO., ILION, N. Y.							
.32 A.C.P.	Model 51 Automatic Pistol	16 R.H.	7	.3045	.03	.311	.105	.0032
.380 A.C.P.	Model 51 Automatic Pistol	16 R.H.	7	.349	.04	.355	.115	.003
.41 Rim Fire	Double Deringer	16 R.H.	5	.394	.08	.401	.170	.0035
	SAVAGE ARMS CO., UTICA, N. Y.							
.32 A.C.P.	Savage Automatic Pistol	12 R.H.	6	.3045	.044	.3105	.115	.003
.380 A.C.P.	Savage Automatic Pistol	12 R.H.	6	.349	.056	.355	.125	.003
	MISCELLANEOUS WEAPONS							
.22 Long Rifle	Buchel Single Shot Free Pistol	14.5 R.H.	8	.214	.012	.223	.075	.0044
.22 Long Rifle	Stotzer Single Shot Free Pistol	15.75 R.H.	6	.214	.027	.223	.085	.0046
.22 Long Rifle	Franz Stock, Berlin, Sport Pistol	15.75 R.H.	6	.215	.034	.221	.0787	.003
6.35 MM (.25 A.C.P.)	Franz Stock, Berlin, Taschen Pistol	9.4 R.H.	4	.245	.054	.253	.138	.004
7.65 MM (.32 A.C.P.)	Franz Stock, Berlin, Taschen Pistol	9.4 R.H.	4	.302	.073	.310	.157	.004
6.35 MM (.25 A.C.P.)	C. G. Haenel, Suhl, Smeisser Pistol	9.4 R.H.	6	.243	.032	.251	.094	.004
6.35 MM (.25 A.C.P.)	Lignose Einhand Pistol, Berlin	7 R.H.	6	.243	.02	.251	.106	.004
6.35 MM (.25 A.C.P.)	J. P. Sauer, Suhl, Pocket Pistol	14 R.H.	6	.243	.042	.251	.085	.004
7.65 MM (.32 A.C.P.)	J. P. Sauer, Suhl, Pocket Pistol	14 R.H.	6	.301	.041	.310	.116	.0045

Note—The reader, in referring to the tables above should bear in mind that the various makers occasionally change their standard factory practice as to dimensions, etc., and that many such changes have occurred in the past and will no doubt be made in the future, so that arms differing from the standards described may be encountered. However, the table represents the best information available to the author as to present practice and should be a valuable reference as indicating the variations among the different makers.

ARMS MADE BY COLT'S PATENT FIREARMS MFG. CO., HARTFORD, CONN.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Long Rifle	"Ace" Automatic Pistol	14 L.H.	6	.214-.215	.036-.040	.221-.222	.071-.075	.0035
.22 Long Rifle	"Woodsman" Automatic Pistol	14 L.H.	6	.214-.215	.036-.040	.221-.222	.070-.075	.0035
.22 Long Rifle	"Camp Perry" Target Pistol	14 L.H.	6	.214-.215	.036-.040	.221-.222	.070-.075	.0035
.22 Long Rifle	"Official Police" Revolver	14 L.H.	6	.214-.215	.036-.040	.221-.222	.070-.075	.0035
.22 Long Rifle	"Officer's Model" Revolver	14 L.H.	6	.214-.215	.036-.040	.221-.222	070-.075	.0035
.22 Long Rifle	"Police Positive Target" Revolver	14 L.H.	6	.214-.215	.036-.040	.221-.222	.070-.075	.0035
.22 Long Rifle	Banker's Special Revolver	14 L.H.	6	.214-.215	.036-.040	.221-.222	.071-.075	.0035
.22 W.R.F.	"Police Positive Target" Revolver	14 L.H.	6	.214-.215	.036-.040	.221-.222	.070-.075	.0035
.25 A.C.P.	Pocket Model Automatic Pistol	16 L.H.	6	.243-.244	.036-.040	.250-.251	.086-.090	.0035
.32 A.C.P.	Pocket Model Automatic Pistol	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32 Pol. Positive	Pocket Positive Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32 Pol. Positive	Police Positive Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32 Pol. Positive	Police Positive Target Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32-20	Official Police Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32-20	Police Positive Special Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.32-20	Single Action Army Revolver	16 L.H.	6	.304-.305	.047-.051	.311-.312	.106-.110	.0035
.380 A.C.P.	Pocket Model Automatic Pistol	16 L.H.	6	.348-.349	.056-.060	.355-.356	.121-.125	.0035
.38 A.C.P.	Super .38 Automatic Pistol	16 L.H.	6	.348-.349	.056-.060	.355-.356	.121-.125	.0035
.38 Pol. Positive	Police Positive Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Pol. Positive	Banker's Special Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Police Positive Special Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Detective Special Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Official Police Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Officer's Model Target Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Shooting Master Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	New Service Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38 Special	Single Action Army Revolver	16 L.H.	6	.346-.347	.055-.059	.353-.354	.120-.124	.0035
.38-40	Single Action Army Revolver	16 L.H.	6	.394-.395	.057-.061	.401-.402	.142-.146	.0035
.38-40	New Service Revolver	16 L.H.	6	.394-.395	.057-.061	.401-.402	.142-.146	.0035
.41 Colt	Army Special Revolver	16 L.H.	6	.394-.395	.057-.061	.401-.402	.142-.146	.0035
.41 Colt	New Service Revolver	16 L.H.	6	.394-.395	.057-.061	.401-.402	.142-.146	.0035
.44 Special	New Service Revolver	16 L.H.	6	.419-.420	.064-.068	.426-.427	.148-.152	.0035
.44 Special	Single Action Army Revolver	16 L.H.	6	.419-.420	.064-.068	.426-.427	.148-.152	.0035
.44-40	Single Action Army Revolver	16 L.H.	6	.419-.420	.064-.068	.426-.427	.148-.152	.0035
.44-40	New Service Revolver	16 L.H.	6	.419-.420	.064-.068	.426-.427	.148-.152	.0035
.45 Colt	New Service Revolver	16 L.H.	6	.444-.445	.069-.073	.451-.452	.156-.160	.0035
.45 Colt	Single Action Army Revolver	16 L.H.	6	.444-.445	.069-.073	.451-.452	.156-.160	.0035
.45 A.C.P.	Government Model Automatic Pistol	16 L.H.	6	.443-.444	.069-.073	.450-.451	.156-.160	.0035
.455 Self Loading	Government Model Automatic Pistol	16 L.H.	6	.450-.451	.072-.076	.457-.458	.156-.160	.0035
.455 Eley	New Service Revolver	16 L.H.	6	.444-.445	.069-.073	.451-.452	.156-.160	.0035

IVER JOHNSON ARMS & CYCLE CO., FITCHBURG, MASS.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Rim Fire	.22 Supershot Revolver	15.75 R.H.	5	.217	.0675	.225	.069	.004
.22 Rim Fire	.22 Protector Revolver	15.75 R.H.	5	.217	.0675	.225	.069	.004
.22 Rim Fire	I.J. Target Revolver	15.75 R.H.	5	.217	.0675	.225	.069	.004
.22 Rim Fire	Safety Hammer Automatic Revolver	15.75 R.H.	5	.217	.0675	.225	.069	.004
.22 Rim Fire	Safety Hammerless Automatic Revolver	15.75 R.H.	5	.217	.0675	.225	.069	.004
.32 S.&W.	I.J. Model 1900 Revolver	23.33 R.H.	5	.303	.0955	.312	.095	.0045
.32 S.&W.	Safety Hammer Automatic Revolver	23.33 R.H.	5	.303	.0955	.312	.095	.0045
.32 S.&W.	Safety Hammerless Automatic Revolver	23.33 R.H.	5	.303	.0955	.312	.095	.0045
.38 S.&W.	I.J. Model 1900 Revolver	23.33 R.H.	5	.350	.1148	.360	.105	.005
.38 S.&W.	Safety Hammer Automatic Revolver	23.33 R.H.	5	.350	.1148	.360	.105	.005
.38 S.&W.	Safety Hammerless Automatic Revolver	23.33 R.H.	5	.350	.1148	.360	.105	.005

Note—The term "Automatic Revolver" as used by this manufacturer means simply that the empty cartridges are automatically ejected by the act of tipping up the barrel to reload.

ARMS MADE BY SMITH & WESSON, SPRINGFIELD, MASS.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Long Rifle	Perfected Single Shot Pistol	15 R.H.	6	.217 -.218	.057	.2225-.2235	.057	.003
.22 Long Rifle	Straight Line Single Shot Pistol	15 R.H.	6	.217 -.218	.057	.2225-.2235	.057	.003
.22 Long Rifle	.22/32 Heavy Frame Revolver	10 R.H.	6	.218 -.219	.057	.225 -.226	.057	.0035
.22 Long Rifle	Model K-.22 Revolver	10 R.H.	6	.2145-.2155	.057	.2225-.2235	.057	.004
.32 S.&W.	Safety Hammerless Revolver	18.75 R.H.	5	.303 -.304	.095	.312 -.313	.095	.005
.32 S.&W.	Hand Ejector Revolver	18.75 R.H.	5	.303 -.304	.095	.312 -.313	.095	.005
.32 S.&W.	Regulation Police Revolver	18.75 R.H.	5	.303 -.304	.095	.313 -.314	.095	.005
.32-20 (.32 Win.)	Military & Police Revolver	12 R.H.	5	.307 -.308	.095	.312 -.313	.095	.003
.38 S.&W.	Safety Hammerless Revolver	18.75 R.H.	5	.350 -.351	.1059	.360 -.361	.114	.005
.38 S.&W.	Regulation Police Revolver	18.75 R.H.	5	.350 -.351	.1059	.360 -.361	.114	.005
.38 Special	Military & Police Revolver	18.75 R.H.	5	.346 -.347	.1034	.356 -.357	.114	.005
.38/44 S.&W. Special	.38/44 Heavy Duty Revolver	18.75 R.H.	5	.346 -.347	.1034	.356 -.357	.114	.005
.38/44 S.&W. Special	.38/44 Outdoorsman's Revolver	18.75 R.H.	5	.346 -.347	.1034	.356 -.357	.114	.005
.38/44 S.&W. Special	.38 Magnum Revolver	18.75 R.H.	5	.346 -.347	.1034	.356 -.357	.114	.005
.44 S.&W. American	.44 American Revolver	20 R.H.	5	.417 -.419	.1335	.429 -.431	.1285	.006
.44 S.&W. Russian	.44 Russian Model Revolver	20 R.H.	5	.417 -.419	.1335	.429 -.431	.1285	.006
.44 S.&W. Special	.44 Military Revolver	20 R.H.	5	.417 -.419	.1385	.429 -.431	.1285	.006
.45 S.&W.	.45 Schofield Model Revolver	24 R.H.	5	.435 -.437	.1293	.447 -.449	.144	.006
.45 A.C.P.	1917 Model Revolver	14.659 R.H.	6	.444 -.445	.075	.450 -.451	.157	.003
.32 A.C.P.	Automatic Pistol	12 R.H.	6	.303 -.304	.058	.312 -.313	.100	.0045
.35 S.&W. Automatic	Automatic Pistol	12 R.H.	6	.310 -.311	.0725	.320 -.321	.095	.005

HARRINGTON & RICHARDSON ARMS CO., WORCESTER, MASS.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Rim Fire	Trapper Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Hunter Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	1906 Model Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Target Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	22 Special Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Sportsman, Single or Double Action	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	New Defender Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Young America Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Premier Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	Hammerless Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Rim Fire	"922" Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 W.R.F.	W.R.F. Revolver	12 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.22 Long Rifle	U.S.R.A. Model Single Shot Pistol	16 R.H.	6	.212-.213	.030	.218-.219	.081	.003
.32-20	Handy Gun	20 R.H.	6	.305	.062	.315	.096	.005
.32 Center Fire	Young America Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	American Double Action Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	1904 Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	1905 Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	"Automatic Ejecting" Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	Premier Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	Hammerless 5 Shot Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.32 Center Fire	Hammerless 6 Shot Revolver	12 R.H.	6	.3025-.3035	.062	.3125-.3135	.096	.005
.38 Center Fire	American Double Action	12 R.H.	6	.350 -.3515	.073	.360 -.3615	.110	.005
.38 Center Fire	1904 Model Revolver	12 R.H.	6	.350 -.3515	.073	.360 -.3615	.110	.005
.38 Center Fire	Automatic Ejecting Revolver	12 R.H.	6	.350 -.3515	.073	.360 -.3615	.110	.005
.38 Center Fire	Hammerless	12 R.H.	6	.350 -.3515	.073	.360 -.3615	.110	.005

Note—The .32 and .38 Harrington & Richardson Arms formerly had 5 grooves instead of six as at present, and at one time the Trapper Hunter, and the 1906 Model with 6 inch barrel had 6 grooves, while the 1906 with 2½ and 4½ inch barrels, and the other .22 models had 5 grooves; and all the .22 models had grooves .005 deep instead of .003 deep as at present. These old standards gave dimensions as shown below:

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Rim Fire	Old 6 Groove Models	12 R.H.	6	.210 -.2115	.042	.220 -.2215	.067	.005
.22 Rim Fire	Old 5 Groove Models	12 R.H.	5	.210 -.2115	.064	.220 -.2215	.067	.005
.32 Center Fire	Old 5 Groove Models	12 R.H.	5	.3025-.304	.094	.3125-.314	.096	.005
.38 Center Fire	Old 5 Groove Models	12 R.H.	5	.350 -.3515	.109	.360 -.3615	.110	.005

HIGH STANDARD MANUFACTURING CO., NEW HAVEN, CONN.

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
.22 Long Rifle	Hi-Standard Automatic Pistol Model B	15 R.H.	6	.212	.041	.218	.070	.003

ARMS MADE BY WEBLEY & SCOTT, LTD., BIRMINGHAM, ENGLAND

Caliber	Name of gun and number of shots	Twist of rifling	Number of grooves	Diameter of bore	Width of lands	Width of grooves	Depth of grooves	Weight of gun
.22 Rim Fire	Saloon Pistol, single shot	15 R.H.	7	.216-.218	.089	.007	.003-.005	2 lb 2¾ oz.
.22 Rim Fire	Aiming Tube, single shot	15 R.H.	7	.216-.218	.089	.007	.003-.005	6″-7½ oz.; 7½″-8½ oz.
.22 Rim Fire	.22 Semi-Auto, single shot	15 R.H.	7	.216-.218	.089	.007	.003-.005	1 lb 8¾ oz.
.25 A.C.P.	.250 Auto. Hammer, 6 shots	10 R.H.	6	.245-.247	.0283	.100	.004-.006	11 oz.
.25 A.C.P.	.250 Auto. Hammerless, 6 shots	10 R.H.	6	.245-.247	.0283	.100	.004-.006	10½ oz.
.320 Revolver	W.P. Hammer Revolver, 6 shots	15 R.H.	7	.301-.303	.0351	.100	.004-.006	1 lb-2½ oz.
.320 Revolver	W.P. Hammerless Revolver 6 shots	15 R.H.	7	.301-.303	.0351	.100	.004-.006	1 lb-2¾ oz.
.32 A.C.P.	.320 Auto., 8 shots	10 R.H.	6	.303-.305	.0286	.130	.005-.007	1 lb-4 oz.
.38 S. & W.	Mark III Revolver, 6 shots	15 R.H.	7	.350-.352	.0320	.125	.004-.006	1 lb-8¾ oz., (6 in.) *
.38 Webley Special	Mark IV Revolver, 6 shots	18 R.H.	7	.350-.352	.0320	.125	.004-.006	1 lb-12 oz. (6 in.) *
.380 A.C.P.	.380 Automatic Pistol, 7 shots	20 R.H.	6	.352-.354	.0384	.125	.007-.009	1 lb-3¼ oz.
9 MM Automatic	9 MM Automatic Pistol, 8 shots	15 R.H.	6	.353-.355	.0498	.135	.004-.006	2 lb-2¾ oz.
.455 Revolver	Mk. I to Mk. VI Revolvers, 6 shots	20 R.H.	7	.441-.443	.0429	.155	.004-.006	2 lb-5¾ oz. (Mk. VI) *
.455 Revolver	Webley-Fosbery Automatic Revolver	20 R.H.	7	.441-.443	.0479	.150	.004-.006	2 lb-8¼ oz. (6 in.)
.455 Self-loading	.455 Self-loading Pistol, 7 shots	10 R.H.	6	.447-.449	.0440	.190	.004-.006	2 lb-13½ oz.*

Caliber	Name of the arm described	Pitch of rifling	Number of lands and grooves	Diameter across lands	Width of lands	Diameter across grooves	Width of grooves	Depth of grooves
		SPANISH PISTOLS						
.63 MM (.30 Mauser)	Star	11.42 L.H.	6	.300	.030	.312	.1225	.006
7.65 MM (.32 A.C.P.)	Llama Model I	L.H.	6	.302	.035	.314	.122	.006
9 MM Short	Llama Model II	L.H.	6	.348	.059	.360	.122	.006
9 MM Short	Llama Model III	L.H.	6	.348	.059	.360	.122	.0035
9 MM Bergmann	Llama Model IV	L.H.	6	.348	.059	.360	.122	.006
.38 A.C.P.	Llama Model V	L.H.	6	.348	.059	.360	.122	.006
.38 A.C.P.	Star	10.625 L.H.	6	.348	.050	.360	.131	.006
.45 A.C.P.	Star	10.625 L.H.	6	.440	.071	.452	.158	.006
		THOMPSON SUBMACHINE GUN						
.45 A.C.P.	Thompson Sub-machine Gun	16 R.H.	6	.443-.445	.0767-.0777	.450-.452	.1517-.1527	.0035

INDEX

A

Accidental marks on bullets, 281
Accidents with ammunition, 128
Accidents with shotguns, 210-215
Adapters, cartridge, 62
Advanced firearms identification, 248
Africa, hunting in, 23
Air cooled guns, 38
Air guns, 64
Alabama, Court Decisions, 295-297
Alexander, King, 42
Alum Chine explosion, 126
Aluminum Oxide, 98
Ammunition, 66
Ammunition, accidents with, 128-129
Ammunition, nomenclature, 93
Ammunition, Shotgun, 87
Ammunition terms, 93
Angle of rifling, 54
Annealing, 69
Anvil of primer, 70
Aplanatic magnifier, 158
Armor piercing ammunition, 76
Arms and the Man, 4
Arms Service Bureau, 147
Army Ordnance Magazine, 147
Asbell, State vs., 303
Askins, Capt. Charles, 95
Assassination of King Alexander, 42
Astra Pistol, 42
Atlas of Pistols, 34-35
Auburn Prison, 7
Automatic arms, 34
Automatic ejector, 22
Automatic Pistol, 35
Automatic Pistol, .30 cal. m. 1918, 63
Automatic rifle, 39
Autopsy, 199
Azide, lead, 117

B

Bacon, Roger, 98
Ball, Shotgun, 89-90
Ball, United States vs., 311
Ballistics, 20
Ballistite, 106
Baltimore, Maryland, 113, 126
Barcelona, proof house, 145
Barrel reflector, 158
Barrel, rifling of, 16, 275
Barrel, section of, 43
Barrel telescope, 158, 165
Barrow, Clyde, 39
Base wad, 26
Bassone, State vs., 307
Bausch & Lomb Optical Co., 160, 166, 173, 182, 183, 249
Bausch & Lomb "Telefier," 166
Bayard guns, 47, 52
BB caps, 68
Beard, Major W. L., 312
Bearden vs. State, 310
Beitzel case, 282
Belts, machine gun, 38
Berdan, Col., 71
Berdan Primer, 70, 71
Bergmann submachine gun, 41
Berkman, People vs., 302
Bess, State vs., 307
Best, Commonwealth vs., 306
Bibliography, 312-324
Binocular microscope, 158, 171-172
Birmingham Proof House, 145
Birmingham Small Arms Co., 65
Black Powder, 73, 96-99, 101, 107, 116, 134, 225, 288
Blank fire powder, 105
Blasting caps, 101, 117-119, 123, 124
Blasting powder, 98, 99
Blue whistlers, 94
Boise Rifle Club, 4
Bolt action guns, 28-29
Bolton, People vs., 298
Bombs, 130
Bond, Geo. H., 8
Bonifacio, Echeverria, 42
Book of the Springfield, 95
Boring of barrel, 16, 42, 275
Bottleneck cartridge, 72
Box, bullet recovery, 158, 166-168, 276
Breech block, impressions of, 15, 16, 27, 28, 68, 70
Briscoe case, 119, 121
British Rifle, cal. .303, 62
Browne & Sharpe, 156
Brownell vs. People, 306
Browning Rifle, 34, 39, 40, 232
B.S.A. rifle, 65
Buck shot, 61, 90, 94, 227-228, 244
Bulk powder, 106, 109, 111
Bullet cannelure, 79-82
Bullet comparison, 257, 258, 277, 278
Bullet holder, 178, 180, 181
Bullet markings, 153, 154, 276
Bullet models, 283
Bullet moulds, 84
Bullet photo stand, 186-188
Bullet, recovery box, 158, 166-168, 276
Bullets, 74-76, 94
Bullets, Armor piercing, 76
Bullets, deformation of, 288
Bullets, Dum Dum, 76
Bullets, Tracer, 76
Bullseye powder, 102, 108, 109
Bundesen, H. N., 314
Burchett, State vs., 307
Bureau of Forensic Ballistics, 13
Bureau of Investigation, 14, 294
Bureau of Standards, 14, 177

Burning cartridges, 129
Bursting of guns, 2
Burrard, Major Gerald, 319
Buxton, Joseph T., Jr., 315
Byrd vs. State, 310

C

Cadmium plated bullets, 74
Calibers, 34, 35, 42, 55-59, 88
California, court decisions, 298, 299
Campbell State vs., 302
Camera, Eastman View, 189
Camera, Photomicrographic, 182-184
Cannelure, 72, 74, 79-82, 85
Cartridge, adapter, 62
Cartridge box markings, 154
Cartridge case, examination of, 259-265
Cartridge markings, 148-152
Cartridges, 94
Cartridges for breech loaders, 67
Cartridges, marks on, 35-37, 287
C. B. caps, 68
Casey, State vs., 308
Cassidy, H. E., 314
Center fire cartridges, 69
Charge, 94
Charletans, 14
Check tests, 288
Choke bore, 60, 88, 217
Churchill, Robert, 318, 319
Class characteristics, 254
Cleveland clinic, accident, 113
Cogswell, John F., 315
Collins, vs. State, 308
Colloid, 102, 112
Colt arms, 31, 47, 53, 55, 72, 143, 196, 244, 246
Colt automatic pistol, 2, 3, 12, 32, 41, 42, 58, 139, 141, 238
Colt Monitor, 39, 40, 232
Colt Patent Firearms Mfg. Co., 12, 39, 51
Colt single action Army revolver, 31
Colt Woodsman pistol, 74
Columbo, Russ, 235
Comparator, screw thread, 162
Comparison microscope, 157, 158, 173-175, 180, 181, 249, 277
Comparison, ocular, 176
Compensator, cuts, 39
Conflicting testimony, 1
Conkling, People vs., 299
Connecticut, court decisions, 299, 300
Conversion tables, 325-329
Cordite, 102, 103
Coroner, 199
Court decisions, digest, 294-311
Crawford, William J., 313
Crimp, cartridge, 83, 85-87
Crossman, Captain E. C., 13, 27, 45, 95, 229, 262, 265, 266, 278, 279, 282, 313-315, 317
Crown tripod, 157-158, 189
Cupro-Nickel, 76, 78, 79
Curtis Bay Ordnance Dept., 113
Cutters, rifling, 43, 44
Cutts compensator, 39

D

Damage suits, 2
Data, collection of, 11
Davis, H. C., 314
Davis, State vs., 309
Daylight glass, 267
Decisions, court, digest of, 294-311
Definitive proof, 144
Deformation of bullets, 288
Dense powder, 110, 111
Department of Justice, 13, 294
Deringer, 68
Destroying explosives, 132
Deterioration of powder, 112, 113
Detonating fuze, 101
Detonation, 101, 125
Detonators, 117-119
Deutche Waffen u. Munitions Fabriken, 152
Differences in personal ability, 19
Difficulties encountered, 287
Digest of court decisions, 294-311
Dimensions of guns, 11
Dimensions, tables of, 330
Direction of rifling, 48
Dissimilarities in bullet markings, 281
Distance at which shot was fired, 204, 205
District of Columbia court decisions, 300, 301
Dominion Cartridge Company, 152
Double base powders, 102-108
Double guns, 21, 23, 24, 26
Dreyse pistol, 12
Drury, John, 314
Dry ice, 98
Dulu pistol, 52
Dum Dum bullets, 76
Du Pont shot gun powder, 106
Dynamite, 100, 117, 122, 123, 125, 126

E

Echeverria, Bonifacio, 42
E. C. powder, 105
Education required, 250, 251
Eibar, Spain, 12, 42, 145
Ejection of fired cartridges, 236, 237
Ejector, 22, 23, 26, 29
Ejector marks, 24-26, 30, 32, 36, 37, 40
Electric blasting cap, 123, 124
Electric squib, 125
Eley Brothers, 153
Ellis, People vs., 299
Enlarged photographs, 186
Evans vs. Commonwealth, 303
Evans vs. State, 297
Evidence, handling of, 246, 247, 281
Evidence, marring of, 281
Expert opinion evidence, rules for, 294
Experts, 14
"Express" bullet, 76
Express pistol, 52
Extractor, 22, 23, 26, 29
Extractor marks, 27, 30, 36, 37, 40

F

Fact vs. opinion, 18
Farrington, People vs., 298
Federal Cartridge Company, 150
Federal firearms act, 42
Filar micrometer, 158, 191-193, 258
Faurot, Inspector, 10
File marks on breech, 32, 33
Firearms act, 42

Firearms, kinds of, 21
Fire, smokeless powder, 113, 114
Firing pin, 16, 254, 265
Firing pin imprints, 260, 272, 273
Fisher, John H., 13, 193
Fisher, People vs., 302
F. N. pistol, 52
Focusing magnifier, 158, 183
Forceps, bullets marred by, 281
Forhand & Wadsworth revolver, 252
Foreign arms, 11
Forensic ballistics, 20
Forensic ballistics, bureau of, 13
Forensic, definition, 20
Foster vs. State, 306
Four barreled guns, 23
Fowler, Lieutenant John H., 157, 190, 251, 252, 294
Frankford Arsenal, 150, 151
Franklin vs. Commonwealth, 304
Frisen, Roy, 318
Fulminate of mercury, 115, 117, 132
Fumes, 113
Fuze, 101, 118, 123

G

Garand rifle, 34
Gardner, I. C., 313
Gas explosions, 131, 132
Gas lacerations, 208
Gatch, Capt. Nicholas B., 120
Gau, Lieut. H. Lawrence, 121, 130, 131
Gauge of shotgun, 56, 88
Georgia, Court decisions, 301
Gilding metal, 76, 78, 79, 270
Glaister, John, 319
Gleason, Commonwealth vs., 306
Gloria pistol, 52
Goddard, Col. Calvin H., 5, 12, 13, 18, 147, 157, 159, 193, 249, 251, 252, 268, 312-318
Goodell-Pratt tools, 156
Gorman, Stanley F., 315
Graphite, 110
Gravelle, Philip O., 13, 314
Gray, Joseph, 317
Grease on bullets, 74, 75, 79
Green, Nelson, 6-9
Greenough type microscope, 17, 158, 171, 172
Grooves, 43-46
Grooves, number of, 2, 51, 52
Guardians, The, 145
Gun cotton, 100, 101, 102, 103, 115
Gunmaker's company, the, 145
Gunther, Professor Charles O., 315, 316

H

Halifax, explosion at, 128
Hall, Dr. A. L., 312
Hammerless guns, 22
Hand loaded cartridges, 84
Harlen, State vs., 307
Harrington & Richardson, 24, 25, 30, 53
Hasslacher, Fritz, 34, 317
Hatcher, Major Julian S., 5, 121, 313, 317
Heel of bullet, 74
Heess, Dr. Walter, 34, 35, 317
Helixometer, 193, 194
Hendel, State vs., 301
Henderson, George C., 313
Hercules Powder Company, 108, 109
Herrick, R. E., 4, 312
Himmelwright, A. L. A., 314
Hi Vel Powder, 102, 104
Holden vs. State, 309
Homicides with shot guns, 210
Hook cutter, 43, 44
Hopkins, Albert A., 316
Hopkins & Allen revolver, 252
Hughes vs. State, 295
Humanitarian Cult, 7

I

Idaho, court decisions, 301
Identification of persons, 285
Identification of powders, 109, 111, 112
Illinois, court decisions, 302
Imperial Chemical Industries, 152
Imperial Valley Murder Case, 278
Imprints, firing pin, 260
Improved military rifle powder, 104, 110
India, hunting in, 23
Individual characteristics, 254, 255
Initiators, 117
Inquest, 199
Instantaneous fuze, 123
Instruments and equipment, 156
Iowa, court decisions, 302
Israel, State vs., 299
Iver Johnson revolver, 30, 53

J

Jack, vs. Commonwealth, 304
Jacketed bullets, 75, 77, 78
"Jena" explosion, 116
Jones, Captain William A., 10
Jones, State vs., 303
Justice, Department of, 5, 13, 294

K

Kansas, court decisions, 303
Kentucky, court decisions, 303, 304
Kent vs. State, 309
Keyhole shots, 235
Kieselguhr, 100, 122
Kirk murder case, 130, 131
Knowledge required to be an expert, 250
Knurling, 80
Krag Jorgensen rifle, 57, 62
Kynochs, 111

L

Laboratorian, 17
LaGarde, Colonel, 208
Lake Denmark, explosion, 128
Lamp, microscope, 173, 181, 188
Landis, C. S., 316
Lands, 43, 44, 46
Lands and grooves, number of, 51
Laney vs. U. S., 300
Lapping, 256
Lawson vs. Commonwealth, 304
Lead azide, 117
Leading, 74, 80
Lefaucheaux cartridge, 67
Legal ballistics, 20
Leitz, Ernst, 249

Lens, micro-teleplat, 185
Lens, microtessar, 158, 184, 185
Lesmok powder, 107, 111
Lever action guns, 28, 29
"Liberté," explosion of, 116
Liège, Belgium, 12, 144
London, 145
Lot markings, 154, 155
Louisiana, court decisions, 305
Low moulds, 94
Lubaloy, 74, 78
Lubrication, 74, 75, 79, 80, 85
Lucas, A., 318
Luger pistol, 42, 137

M

Machine guns, 21, 34, 38
Machine rifles, 39
Machining, effects of, 16, 42, 45, 275
Magazines, 28
Magnesium, 76
Magnet, 158
Magnet test, 79
Magneto, blasting, 124
Magnification, 170
Magnifier, aplanatic, 158, 160, 161
Magnifier, focusing, 158, 183
Magnifying glass, 160, 161
Maldeis, Doctor Howard, 121
Mannlicher-Schoenauer, 62
Marble Arms & Mfg. Company, 62
Mark I Springfield rifle, 63
Markings on arms, cartridges, etc., 135
Markings on head of case, 33, 70, 261, 268, 269, 287
Marks of rifling, 49, 50
Marks on cartridges, 35, 36, 260-263
Marseilles, 42
Maryland court decisions, 305
Massachusetts court decisions, 305, 306
Matched lenses, 177
Mauser pistol, 41, 42
May, Luke S., 14
McKelzey on evidence, 294
Measures, length, 325
Measures, liquid, 328
Measuring rifle marks, 49
Medical examiner, 199
Melior & Stenda pistol, 52
Mercury fulminate, 115, 117
Metal fouling, 78, 82
Metal jacketed bullets, 76
Metallics, 94
Metric system, 325-329
Mezger, Doctor Otto, 34, 317
Michigan court decisions, 306
Micrographs, 186
Micrometer calipers, 158, 160
Micrometer, Filar, 158, 191-193
Micrometer, how to read, 163
Micrometer, stage, 158
Microscope, 158, 169
Microscopic examination of bullets, 17, 257, 258, 277, 278
Mississippi, court decisions, 306
Missouri, court decisions, 307
Model bullets, 283
Modelers' clay, 179
"Modern shot guns and loads," 95
Montana, court decisions, 307
Morro Castle, Santiago, 64
Morro Castle, Steamer, burning of 115
Moughton vs. State of Georgia, 301
Moxley, Spencer B., 316
"Mushrooming," 76
Muzzle loaders, 66
Myers, Harry J., 316
Myers vs. the State, 310

N

Nagle, State vs., 308
National Matches, 71, 141
New Jersey, court decisions, 307
Newkirk vs. State, 305
Nitro-cellulose, 100, 109, 110
Nitro explosives, 100, 102
Nitro-glycerine, 100, 102, 108, 109 115, 122
Nitro-lignin, 105
Nitrous oxide fumes, 113
Noise of firearms, 239
Nomenclature of explosives, 128
Non-corrosive primers, 73
Nordmark, State vs., 303
Northwestern University, 13
Number of grooves, 2

O

Ohio, court decisions, 307
Oklahoma, court decisions, 308
O'Leary, Captain Clarence, 118
O'Leary, N., 317
Ordnance Department, 109, 141, 145 232
Oregon, court decisions, 308

P

Pacific Gun Sight Company, 164
Pattern of shot, 94
Pattern, spread of, 226
Pedersen device, 63
Pedersen, J. D., 58
Penetration, 208, 209, 231-234
Penetration in water, 234
Penniman, Doctor W. B. D., 121
Perforated powder, 103
Peters Cartridge Company, 149
Peterson, Captain C. A., 14, 317
Phelps, Charles B., 6, 8
Phillips vs State, 297
Photographs for record, 19
Photographs, handling of, 283, 284
Photographs, retouching, 284
Photomicrographic camera, 182-184
Photomicrographic lenses, 184-185
Pickert pistol, 52
Pin-fire cartridges, 67
Pin, firing, 16
Pistol, Atlas, 34, 35
Pistol, powder, 107, 108
Plasticine, 179
Pollard, Hugh, 318
Pollock vs State, 311
Poser, Doctor Max, 10
Post-mortem examination, 199
Post-mortem physician, 281
Powder, black, 73, 96-99, 101, 107, 114, 132, 225, 288
Powder, blasting, 98, 99
Powder, "brand", 206, 207
Powder, burns, 205-207
Powder, marks, 206, 207

Powder, pyro, 103
Powder, residue, 288
Powder, samples, 111
Powder sizes, 99, 107
Powder, smokeless, 73, 88, 102, 103, 107, 111, 115, 132
Powders and explosives, 96
Powders, shot gun, 106
Paradox gun, 61
Pitch of rifling, 47-49
Primer, markings, 27, 28, 33, 70, 261, 266, 268-270, 273
Primers, 16, 69, 73, 117
Princeps pistol, 52
Principal dimensions of arms, 330
Prism, 158
Probability, theory of, 285-287
Progressive powder, 103, 104
Proof marks, 136-149
Proof tests, 143, 144
Provisional proof, 144
"Punkin ball", 95
Pyas vs State, 295
Pyro powders, 103-110

Q

Quackery, 14
Qualifying the expert, 19
Quinn vs State, 308

R

Range at which shot is fired, 222-224
Range, extreme, 228-231
Rate of fire, machine guns, 38
Reaming, 16, 42, 275
Reflector, barrel, 158
Reloading, 84 85
Remington Arms Company, 34, 68, 108, 139, 149
Remington pistol, 2, 12, 52, 53
Remington rifle, 62, 68
Repeating guns, 21, 28
Report of gun, 242, 243
Revolver 21, 30, 31
Rhenish-Westfalisch Sprengstoff A G., 152
Rhode Island, court decisions, 308
Ricochets, 234, 235, 241, 242
Rifle powder, 111
Rifle, repeating, 21
Rifled bullet shell, 63
Rifling, 42, 43
Rifling, angle of, 54
Rifling cutters, 42, 43
Rifling, direction of, 48, 196
Rifling marks, 49, 50
Rifling of the barrel, 16, 275
Rifling, pitch of, 47-49
Rifling standards, 46
Rim cartridges, 71
Rim-fire cartridges, 67, 68
Rimless cartridges, 37, 71, 72
Riot gun, 61
Rule, flexible steel, 158, 164
Rusty barrel, effect of, 288-291

S

Sacco-Vanzetti case, 268, 269
Safety lock, 214
Sanders vs State, 297
Santiago, bombardment of, 64
Savage automatic pistol, 37, 53, 252
Savage rifle, 62
Scale, flexible steel, 158, 164
Scales, powder and bullet, 158, 164
Schmeisser pistol, 52
Schultz, Captain E, 106
Schultz, Doctor Otto, 10
Schultz powder, 106
Scientific crime detection laboratory, 13
Scrape cutter, 43, 44
Screening powder, 110
Section of barrel, 43
Segmental crimp, 83
Semi-rim cartridge, 37, 71, 72
Semi-smokeless powder, 111
Separate anvil primer, 70
Serhaut, Joseph E, 315
Serial numbers, 135, 139
Set-back of primer & Cartridge, 27
Sharpshooter powder, 109
Shooting galleries, liability of, 2
Shot, 89, 90, 92
Shot size table, 91, 92
Shotguns, 21, 56, 60, 205, 210-228
Shotgun balls, 89, 90
Shotgun gauges, 88, 89
Shotgun killing range, 215, 216
Shotgun powders, 106
Shotgun shells, 87, 93, 94
Shotgun shell construction, 212
Silencers, 240
Single-shot weapons, 21
Size of powder grains, 99
Size rule for shot, 91
Skewer, 123, 124
Skidding of bullets, 50
Skid marks on bullets, 51
Slag 98
Smith, Emory, 315
Smith, James, State vs, 300
Smith vs State, 296
Smith & Wesson, 12, 32, 51, 52, 58, 62, 67
Smith & Wesson Revolvers, 3, 53, 59, 72, 197, 198, 244, 245, 264
Smokeless powder, 73, 88, 102, 103, 107, 111, 115, 132
Smith, Sidney, Dr., 318, 319
Snyder et al, Commonwealth vs, 305
Souder, Dr. Wilmer, 251, 314, 316, 317
South Carolina Court Decisions, 309
Spanish American War, 57
Spanish Guns, 12, 47, 52
Spencer Lens Co., 171, 173, 174, 176-178, 181, 182, 185, 188, 194, 249, 277
Spitzer bullet, 57
Spontaneous combustion, 113
Springfield Armory, 138
Springfield Rifle, 40, 47, 56, 57, 63, 104, 137, 232, 239, 243
Squibs, Electric, 125
Stab crimp, 86, 87
Stack, Sir Lee, Pacha, 267
Stage micrometer, 158
Stand, bullet photographing, 186-188
Standards, Bureau of, 14, 177
Standards of bore and rifling, 46
Star gauge, 4, 59
"Star" pistol, 42
Starrett, L. S., tools, 156, 161, 164
Static Electricity, 110
Steel jacketed bullets, 76, 79
Stevens rifle, 62
Stielow Case, The, 5-10, 15

Stielow, Charlie, 5-10
Stout, Wesley W, 313
Streight vs State, 310
Stripping of bullets, 74
Stuttgart, Germany, 35
Submachine gun, Thompson, 40, 41, 53, 262-264
Suicide vs Accident, 209, 210
Sullington, Don, 314
Supplementary case markings, 264
Suskin, N, 315
Symonds, C. T., 318

T

Table of dimensions of guns, 330
Table of powder sizes, 99
Table of rifling angles, 54-55
Table of shot sizes, 94
Table of weights & measures, 325-329
Tangen, Ed., 316
Taper gauge, 164
Taylor, J., 316
Teale, Edwin W., 316
Telescope, barrel, 158, 165
Test bullets, 276, 277, 280
Testimony, conflicting, 1
Tetryl, 127
Texas, court decisions, 309, 310
Thames revolver, 236
Thermite, 97
Thompson submachine gun, 36, 40, 41, 53, 262-264
Three-barreled guns, 23
T. N. T., 101, 117, 125, 127, 128
Tracer bullet, 76
Tracer shotgun shell, 90
Trombone action guns, 28
Twist of rifling, direction of, 47
Twist of rifling, measuring, 49

U

United States Cartridge Company, 149, 153
United States, Court decisions of, 311

V

Variations in primer markings, 270, 273
Vertical Illuminator, 17, 171
Vesuvius, dynamite cruiser, 64
Villar Perosa Submachine gun, 41
Voland & Sons, 164
Voland Pulp Balances, 164
Voorhies, State vs, 305

W

Wadding, action of, 218, 225, 226
Wadding, shotgun, 88, 89, 93, 213, 218, 219-222
Waite, C. E., 5, 8, 10, 11, 12, 13, 14
Waldmann pistol, 52
Wark, R., 316
Washington, Court decisions, 310
Watchmaker's glass, 158, 161
Water cooled guns, 38
Webley & Scott Pistol, 34
Weight, units of, 327
Wells, J. Bernard, 121
Wescott, Allen P., 316
Wesson, Major Douglas B., 58
Western Ctg. Co., 149
Wiard, Major Seth, 315, 316
Wide field binocular microscope, 172
Wigmore, John H., 315
Wilhelm, Major G. P., 229
Williams, C. G., 312
Willis, People vs, 298
Wilson, Col. Louis B., 312
Winchester Repeating Arms Co., 62, 149, 153
Winchester rifle, 34, 68, 72
Wisconsin, Court decisions, 311
Wise vs State, 296
Wollcott, Miss, 8, 9
Wood, Dr. Robert W., 120
World War, 71
Wounds, examination of, 200
Wounds of entrance and exit, 201-203
Wounds, size of, 225
Wrong cartridge, use of, 245, 246

X

Xylene, 274

Y

Z

Textbook of
PISTOLS *and* REVOLVERS
Their Ammunition, Ballistics and Use

Copyright 1935
By
Small-Arms Technical Publishing Co.

PRINTED IN U.S.A.

TABLE OF CONTENTS

PART 1. ARMS

PAGE
1. MODERN HANDGUNS. GENERAL INFORMATION 1
2. TARGET ARMS AND OUTDOORSMAN'S GUNS 17
3. MILITARY REVOLVERS AND AUTOMATICS 75
4. POCKET AND HOME DEFENSE HANDGUNS 113
5. TECHNICAL NOTES ON HANDGUNS 141
6. ACCESSORIES 240

PART 2. AMMUNITION

7. GENERAL INFORMATION ON AMMUNITION 275
8. INTERIOR BALLISTICS 287
9. EXTERIOR BALLISTICS 309
10. INDIVIDUAL DESCRIPTION OF CARTRIDGES 323
11. TECHNICAL NOTES ON AMMUNITION 383
12. BULLET EFFECT AND SHOCK POWER 401

PART 3. SHOOTING

13. LEARNING TO SHOOT 439
14. PRACTICAL SHOOTING 479
15. SHOOTING IN SELF DEFENSE 492
16. THE PEACE OFFICER AND HIS GUN 513

INTRODUCTION

While this is a book on firearms, it does not by any means cover the whole subject, for the broad general term "Firearms" is an extremely comprehensive one, which includes every weapon that uses gunpowder, from the heaviest piece of Railway Artillery down to the smallest Vest Pocket Pistol. To treat this whole field, even in an elementary and most perfunctory manner would require many volumes.

Firearms may be divided into the two main classes of Artillery and Small Arms. Small Arms, in turn, comprise several subclasses, such as, *Machine Guns;* rifles and shotguns, or *Shoulder Arms;* and pistols and revolvers, or *Hand Firearms.*

It is this last mentioned class of weapons, pistols and revolvers, or Hand Firearms, that forms the subject of this book. An attempt has been made to tell the reader as much as is possible in one volume about the guns themselves; the different methods of shooting and using them; their mechanism, care and repair; their Interior and Exterior Ballistics; the peculiar suitability of the different kinds for various purposes; the relative effectiveness or stopping power of the various calibers and types of gun and ammunition; and many other related subjects.

In writing on this subject, the author has assumed that the reader may be either a novice who knows nothing whatever about firearms and their use, or an advanced expert who wants a technical reference book where the results of many experiments with pistols and revolvers and their ammunition are tabulated in convenient form. Under these conditions it is inevitable that some of the things included will seem to the advanced reader to be too simple and elementary; while at the same time much that is treated here will seem to the beginner to be too technical.

An earnest effort has been made to combine these various classes of material in such a manner that the advanced reader may omit everything that seems to cover ground that is already familiar, while the beginner should read in each chapter only far enough for his present needs, reserving the more technical parts until familiarity with and interest in the subject of hand firearms and their use will lead him more deeply into the study of everything connected with them and their ammunition.

No effort has been made here to cover the Handloading of Ammunition, for this is a very large subject, and a Textbook of Handloading would be a complete volume in itself. Moreover, such a work is already available, under the title *Handloading Ammunition,* by Mattern, to which the reader who is interested in this subject is referred.

In *Pistols and Revolvers and Their Use,* written by the present author in 1927, a considerable amount of space was given to the history and development of hand firearms and their ammunition. No such material is included in the present *Textbook;* for the amount of live and up-to-date material available was such that the author found himself mainly concerned with the problem of getting all this material into one single volume of reasonable size.

Thus this book is essentially a treatise on *modern* Pistols and Revolvers and their Ammunition, with only such references to and descriptions of the older weapons and cartridges as are considered necessary to illustrate certain technical points under discussion, or to serve as a reference regarding some of the older guns more commonly still in current use.

Annapolis, Maryland
December, 1934

PART I

ARMS

CHAPTER 1

MODERN HAND-GUNS—GENERAL INFORMATION

HAND firearms may be divided into various classes according to the mechanical construction, the use for which intended, or the caliber.

When considered from a constructional point of view, they would be classified as single shot pistols or repeating pistols (which includes automatic pistols and revolvers). When considered as to use, they would be classified as:

Military Arms.
Target and Outdoorsman's Arms.
Pocket and Home Defense Arms.

When considered as to caliber, they are named for the diameter of the bullet in hundredths of an inch. Thus the smallest common type is the .22 caliber, in which the bullet is .22 of an inch in diameter and has a 30-grain lead bullet. The largest common type is the .45 caliber, with a 255-grain bullet.

SINGLE SHOT PISTOLS

The old military horse pistols were ordinarily single shot weapons, and in later years single shot cartridge pistols were much used in the army and navy. A sample is the .50 caliber Remington Pistol which is now much prized among target shots for conversion to .22 caliber and use as a target weapon.

While the revolver and automatic pistol have long ago ousted the single shot for military use, it is still a favorite for certain types of target practice. A single shot pistol gives greater accuracy than any other known type because it is not necessary to have a separate cylinder to hold the cartridge as is the case with a revolver, in which the bullet must jump a gap between the cylinder and barrel, nor is it necessary to have the barrel movable as is the case with many automatic pistols. Moreover, the sights on the single shot pistol can be fixed firmly to the barrel instead of being a separate part, such as the slide, as they are on some automatic pistols.

In this country the rules limit the length of barrel of an automatic pistol to ten inches and also limit the distance between sights to the same figure, so that most single shot guns intended for target use have a ten inch barrel and ten inch sight radius. However, there are a number of single shot pistols with six to eight inch barrels, which are used principally as auxiliary arms in hunting, trapping, camping, etc. Moreover a number of target shots are now using barrels of 7 or 8 inches in length in preference to the 10 inch.

Most single shot pistols are shaped like a revolver, with curved handles, but there are some which have been built on the lines of the automatic pistol.

In a gun built for target use, such as the modern single shot pistol, there is no reason for having double action lock-work, hence most of the later ones are of the single action type which conduces to simple lock-work and a quick, clean action that is well suited to getting the best accuracy with a target arm.

Formerly single shot pistols were made in various calibers but now they are made only in .22 caliber.

REPEATING HAND-GUNS

Repeating hand-guns as distinguished from single shot pistols, embrace both revolvers and automatic pistols, and some repeating pistols that are neither revolvers nor automatics. One example is the Fiala repeating pistol which is made like an automatic pistol with a magazine in the handle, though it does not operate automatically. Instead, the breech must be opened and closed by hand each time the gun is fired and the opening and closing of the breech extracts the old cartridge from the barrel and inserts a fresh cartridge from the magazine in the handle.

The revolver in practical form dates from 1836, and is either of the earlier single action type in which the hammer must be cocked by hand for each shot, or of the later double action type in which the hammer may either be cocked by hand for each shot or may be cocked by simply pulling on the trigger.

When a gun, either single or double action, is cocked by hand, the only work that the trigger has to do is to hold the hammer in its cocked position until pressure is applied; then it must release its engagement with the hammer and let the hammer drop. This can be accomplished with very little pressure or work. On the other hand, with a double action gun if the hammer is to be cocked by pulling on the trigger, it is obvious that in the first place a considerable motion of the trigger is necessary in order to lift the hammer and that a considerable amount of work must be done by the trigger finger. Thus shooting a gun "double action" is usually far harder to accomplish with accuracy than shooting "single action." All modern double action guns are made so that they can be operated in the single action style by first cocking the hammer by hand.

The first Colt revolver, patented in 1836, had a single action, and this type of mechanism was so satisfactory that single action revolvers of almost identical lockwork are manufactured and sold in quantities today by the Colt's Patent Fire Arms Mfg. Company. It is interesting to note that only very recently another manufacturer, Harrington & Richardson, has placed on the market a single action .22 caliber target revolver.

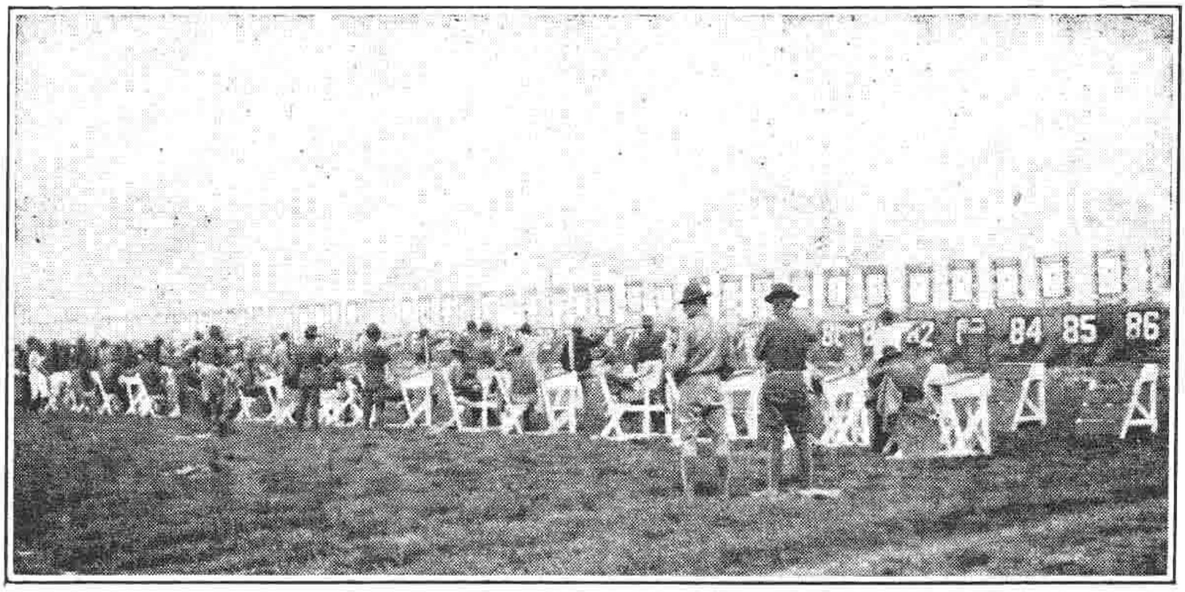
AUTOMATIC PISTOLS

All automatic pistols are what is more properly known as "semi-automatic" or "self-loading." An "automatic" gun, strictly speaking, is one that keeps firing as long as the trigger is held, such as the machine gun. But one pistol is made in this way at the present time. The automatic pistol is made so that each time the trigger is pulled, a cartridge is fired, the empty shell thrown out, the hammer cocked and a new cartridge fed into the barrel ready to be fired again by a second pull of the trigger. Merely holding the trigger down will not make the second shot go off. The trigger must be released and then pulled again.

There is a little device in the automatic pistol called the disconnector, which is designed to prevent more than one shot from being fired by a single pull of the trigger. As soon as the slide of the pistol moves to the rear, the disconnector disengages the sear from the trigger so that the trigger must be released and obtain a fresh hold on the sear to make the second shot.

If pistols were made so that they are fully automatic, the whole magazine full of shots would go out in a small fraction of a second as soon as the trigger was pulled. There was a very small Italian-made sub-machine gun tested by the Government during the early part of the war, known as the Villar Perosa. This gun has a magazine containing fifty Luger pistol cartridges and is fully automatic. When the trigger was pulled all fifty shots were fired in a little over a second, so that it just sounds like tearing a piece of canvas instead of like a number of separate shots.

During the early part of the World War an automatic pistol was changed over at Springfield Armory so as to work automatically, with the idea of possibly using such a weapon in aircraft combat. The mechanism functioned so rapidly that when the trigger was pulled all the shots went out at one time and it was hardly possible to distinguish the report of seven shots from one prolonged report. Moreover, the rapidly repeated recoils of these different shots coming one after the other, threw the gun upward and backward so that it was impossible to hold it down even when using both hands. The writer fired this gun a number of times and it was a very curious sensation to fill the magazine, load the gun, take careful aim at the target, and suddenly find the gun empty and pointing at the sky, regardless of the amount of effort made to hold it down.



On the firing line at Camp Perry. The National Individual Pistol Match of 1931.

In the discussion of pistols, individuals will often be encountered who insist that automatic pistols will fire one shot after another as long as the trigger is held down and the cartridges last. They are entirely mistaken and it will be seen from the above mentioned example that to make a gun this way would be very foolish, for in the first place, it would be, in effect, like having only one shot. The first shot might hit the point of aim but the others would all go wild and they would be fired so quickly that there would be no chance to let go in time to fire a second time.

Automatic pistols date from about 1893 when the Mauser pistol first became prominent. In most small automatic pistols, such as the .25, the .32 and the .380, the breech block is merely held against the head of the cartridge by a strong spring. When the gun is fired, the pressure of the powder gas forces the bullet forward out of the barrel and forces the cartridge backward. But before the cartridge can move backward, it must push the breech block out of the way and this requires comparatively speaking a considerable amount of time. Hence the bullet is gone before the breech actually opens.

The speed at which the breech opens depends largely on the weight of the breech block and the weight of the bullet. The heavier the bullet, the more quickly the breech will open, other things being equal. Hence with very heavy bullets or strong powder charges, it will be necessary to have a large and heavy breech block to make an automatic pistol work satisfactorily on the "blow-back principle" which has just been described.

For this reason most high powered pistols such as the military pistol, have a locked breech; in other words, one that has some sort of device to positively lock the breech block to the barrel until the bullet is gone, the same as the bolt of the Springfield rifle is locked to the barrel by turning the bolt handle down and causing the locking lugs to engage in the recess cut for them.

Of course, in the Springfield rifle it is quite easy to design such a mechanism because the owner of the rifle shuts the bolt and locks it by hand before firing and will have to unlock the bolt by hand after firing. In automatic pistols these operations must be accomplished by the force of the explosion itself. The most common way of doing this is by using the recoiling barrel. The barrel of the gun is mounted so that it can slide backward and forward against the action of a spring. Normally the spring holds the barrel forward and the breech block is locked to the back end of the barrel. However, when the gun is fired the barrel moves back under the force of recoil and this backward motion of the barrel withdraws the bolt or other device which locks the breech block to the barrel.

REVOLVER vs. AUTOMATIC PISTOL

In late years there has been a great deal of discussion as to the relative merits of the revolver and the automatic pistol. A great host of automatic pistols have been invented and manufactured with varying degrees of success. In military sizes the automatics have reached the greatest perfection, and have been adopted by the United States Army, and by many other important armies. In pocket sizes automatic pistols are sold throughout the world in very large numbers. Nevertheless, the revolver has been holding its own during all this period, and is now manufactured in quantities apparently as large as ever. It is difficult to say which is actually better, the revolver or the automatic pistol. Each has its own distinct advantages and disadvantages, which the reader must decide for himself. I will enumerate some of the advantages and disadvantages of each type of weapon.

The revolver has the following advantages:

1. It is an old standard weapon, everyone is used to it, and most everyone knows something about how to handle it.
2. The revolver is safer for inexperienced people to handle and to carry than the automatic pistol.
3. The mechanism of a revolver allows the trigger pull to be better than that of the average automatic.
4. A misfire does not put a revolver out of action.
5. A revolver will handle satisfactorily old or partly deteriorated ammunition which gives reduced velocities that would jam an automatic.

Among the principal disadvantages of a revolver as compared to an automatic are the following:

1. It is more bulky to carry.
2. The grip is generally not as good.
3. It is slower to load.
4. It is hard to clean after firing.
5. It is harder to replace worn or broken parts on a revolver than on an automatic.
6. Replacement of a worn or corroded barrel is a factory job.
7. Worn or poorly made weapons are subject to variable accuracy, due to improperly lining up cylinder or due to not locking cylinder properly in line with barrel.

The advantages of the automatic pistol are:

1. It has a better grip—fits the hand and points naturally.
2. It is more compact for the same power.
3. It is easier to load than a revolver.
4. It is easier to clean.
5. In case of a worn or corroded barrel a new one can be put in at small expense without sending the gun to the factory.
6. It gives a greater number of shots for one loading than a revolver.

7. It gives greater rapidity of fire and greater ease of rapid fire.
8. There is no gas leakage or shaving of bullets.

The automatic pistol, on the other hand, has some serious disadvantages, among which are the following:

1. The ammunition must be perfect. Old and deteriorated ammunition will cause a jam.
2. A misfire stops the functioning of the gun.
3. When the gun is kept loaded for long periods of time the magazine spring is under a tension and may deteriorate, causing trouble.
4. The automatic can not use blanks or reduced loads.
5. It has a poorer trigger pull than the revolver.
6. The magazine action requires a jacketed bullet which is not as good for practical use as a lead bullet.
7. The automatic pistol is more dangerous to handle, especially for inexperienced people, owing to the fact that after one shot it is always cocked and loaded.
8. It is not well adapted to reloading. It throws away the empty shells at each shot.
9. Many automatics eject empty cartridges toward the face, causing flinching.
10. It can not be fired from the hip as it throws cartridges into the shooter's face.
11. It throws out empty cases on the ground to remain as evidence.
12. It can not be fired from the pocket without jamming.
13. In some makes the hammer bites the hand or the slide strikes the hand and causes injury.

By far the most serious of all these disadvantages of the automatic pistol is its inability to use ammunition that is not up to the mark. For a weapon to use under any and all conditions where failure to function may be fatal, and where any and all kinds of ammunition may have to be used, the revolver is still far and away ahead of the automatic pistol, and is likely to remain so indefinitely. It is, therefore, still the choice of explorers and others to whom the possession of a hand arm in functioning condition is of paramount importance.

On the other hand, the automatic pistol is generally considered superior to the revolver for military use, where the ammunition supply is of known quality and spare parts are available.

The .45 Army automatic became extremely popular during the World War, and the experience with this arm at that time thoroughly justified the judgment of the Army authorities in adopting this as the service side arm for all branches of the Army.

For home defense use the small pocket automatic, which is usually hammerless, has the disadvantage of frequently lying for long periods of time with the magazine full of cartridges and the safety on. The magazine spring and mainspring may thus be kept under compression for perhaps years at a time. If at the same time the ammunition deteriorates from age, the result may be that the arm will not function when needed. Moreover, these small automatics always have safeties, which are an excellent thing for one who uses these guns enough to know all about how they function; but if one of these weapons becomes needed in an emergency by some member of the household who does not know much about using hand arms, it may very well occur, and has occurred, that the user was not familiar with the method of manipulating the safety and therefore could not fire the gun. These disadvantages are not shared by the revolver.

We will now consider the different classes of hand firearms according to the uses for which they are intended.

MILITARY ARMS

Most armies and navies use a heavy caliber automatic pistol or revolver as the service sidearm. These guns are usually of .38, .45 or .455 caliber. Opinion as to relative desirability seems to be about equally divided between revolvers and automatic pistols. The United States Government's standard sidearm is the caliber .45 Colt Automatic. The Germans use the 9 m/m Luger which is a .38 caliber. The British have for many years used .455 automatic pistols in the navy and the .455 service revolver in the army; but it is understood that they are now considering the adoption of a .38 caliber revolver as their service sidearm.

Most military revolvers and automatic pistols have fixed sights and are strong and rugged in construction. Naturally they are much used in target shooting as there are many competitions which require the use of the standard government arm, but in general, military arms are not especially designed for target practice and, therefore, lack the adjustable sights and the fine lock-work that characterizes those especially built for target use.

TARGET AND OUTDOORSMAN'S GUNS

Target handarms run all the way from .22 caliber up to .45 and are of all weights and sizes. They include single shot pistols, revolvers, and automatics.

In recent years, however, there has been a strong tendency for target practice with revolvers or automatic pistols to follow three distinct lines. First, the .22 caliber, which is just target shooting reduced to the ultimate in convenience, safety and simplicity, using the lightest possible cartridge that is capable of extreme accuracy, that is, the .22 Long Rifle. In the .22 caliber target practice, slow fire with single shot pistols preponderates.

Then there is a type of target shooting which originated from the needs and requirements of the police and peace officers. This usually involves both slow and rapid fire with revolvers and automatic pistols of .38 or larger caliber, having adjustable sights.

Then there is the military pistol shooting which also involves slow and rapid fire with strictly military guns having sights which are not adjustable.

In considering the arms used for target practice we find, therefore, that they include guns of almost every size and shape.

The weapon which is most purely a target gun is the single shot pistol now made only in .22 caliber. Single shot pistols are usually made with 10-inch barrels so as to get the advantage of all that the rules allow in barrel length and sight radius; though recently shorter barrels are coming into favor and now many target pistols have seven inch barrels. All target revolvers and pistols have adjustable sights and usually they have many other aids to accurate shooting, such as specially fine trigger pull, curved or checked triggers, etc.

The principal automatic pistol in the special target class is the Colt Woodsman .22 which is made with either a 6½ or a 4½ inch barrel. Target revolvers usually have 6, 6½ or 7½ inch barrels.

Recently Smith & Wesson in placing on the market their .38/44 Outdoorsman revolver, made the following statement: "An Outdoorsman's revolver is one that uses a cartridge having high velocity, flat trajectory for unknown ranges that can only be estimated, wind-bucking qualities above the average, and shock-power far above the expectancy of the caliber; that has a clean crisp trigger pull so that it can be shot accurately; that has a barrel not only long enough to insure ample distance between the sights, but also so weighed and balanced as to avoid any effect of either undue weight or muzzle lightness. It must have sights with perpendicular and parallel sharp edges so no reflected light will affect the shooter's aim; they must be of such design that they most easily adapt themselves to various visions and must be adjustable to the individual, and, when adjusted, remain unchanged; and, above all, this revolver must be the utmost in reliability and accuracy."

Smith & Wesson also called their K-.22 heavy frame revolver an "outdoorsman's revolver." It will be seen, therefore, that an outdoorsman's revolver, as described by Smith & Wesson, is the same as a target revolver except for the use of "a high velocity, flat trajectory cartridge with shock power far above the expectancy of the caliber." In other words, according to this definition, an outdoorsman's revolver is nothing more or less than a target revolver which is designed to use not only the regular target cartridge, but an ultra-high velocity cartridge such as the .38/44 or the high-speed .22. Accordingly, outdoorsman's revolvers will in this book be considered with target revolvers.

POCKET AND HOME DEFENSE ARMS

These are automatic pistols or revolvers, usually of .38, .32 or .25 caliber which are adapted to the use of detectives, policemen, peace officers, and others who may want to carry a revolver in the pocket; or for the citizen or householder who may need a gun for personal or home defense. Guns of this class usually have fixed sights and barrels ranging from two to four inches in length. Many of the revolvers are hammerless; in other words, double-action revolvers with hammer concealed so that they may be fired merely by a long pull on the trigger. While as mentioned above, guns of this type usually have fixed sights, there are matches in the U.S.R.A. for pocket revolvers and generally the guns used in these matches have sights that are adjustable.

MISCELLANEOUS GUNS

Among the miscellaneous weapons that might be mentioned here is the Thompson Sub-Machine gun which, while it is not a pistol in any sense of the word, nevertheless uses the caliber .45 pistol cartridge.

Then there are special pistols made for shooting blank cartridges for starting races, athletic events, etc. Most of these use .22 caliber blank cartridges. Some of them, such as the Walther, sold by A. F. Stoeger, Inc., of New York, use a special .22 caliber blank cartridge, made very very short, and crimped, so that it is shaped very differently from any ball cartridge. Thus the gun can be made so that ball cartridges cannot be used in it. For this reason it can be sold without a permit in many states which do not allow the sale of pistols and revolvers.

These blank cartridge pistols are often made so that there is no opening at all in the muzzle of the gun, and the noise and smoke escapes through a hole in the top of the frame. Thus if the gun is pointed at some person and discharged, no damage can be done by sparks and particles of powder being blown in the victim's face, as might very well happen when a blank cartridge is discharged directly at a person in an ordinary gun. Recently the authorities of one of our large cities raided an establishment suspected of unlawful activities, and among other suspicious articles, found one of these small blank cartridge pistols, with the hole in the top of the frame, and no hole in the muzzle. They had never seen one of them before, and were so much mystified by their find, that they wrote to the War Department for information, which was furnished by the author, to whom the communication was referred to answer.

AIR PISTOLS

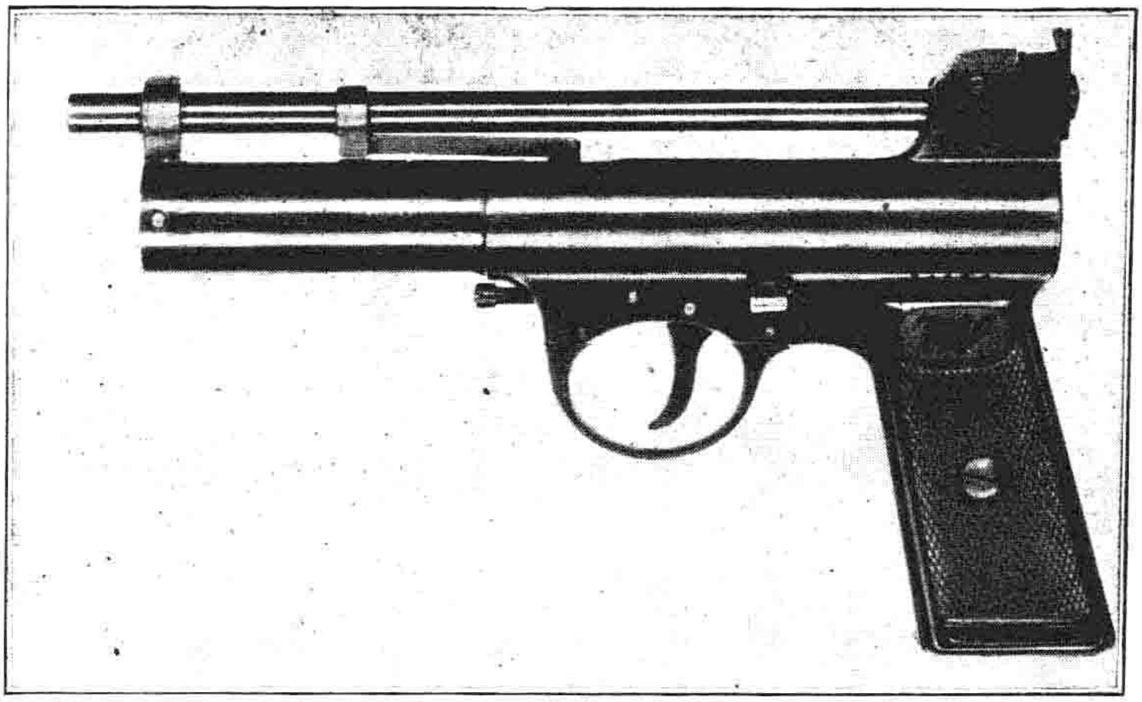
There are on the market several different makes of air pistols, suitable for target practice, and very convenient because of the lack of noise, smoke, and smell, and the fact that they do not have to be cleaned. These guns all operate by the sudden compression of air in a cylinder by a spring-driven piston released by the trigger. The air escapes through the barrel, driving the bullet before it.

As the power available is limited by the necessity of making the mechanism sufficiently light and compact to be contained in a pistol, only very small and light bullets can be used, and they cannot be given a very high velocity. Nevertheless, the results obtained make the better air pistols very respectable weapons to use against small animals, such as rats, mice, etc., and they are excellent for target practice indoors. The power of the small bullet is such that it will penetrate a half inch or more into flesh, and these guns must therefore be used with all the safety precautions customary with firearms.

Air pistols are in general made in two calibers, .177 and .22. They are rifled, and shoot the same pellet that is used in the famous B.S.A. (Birmingham Small Arms) Air Rifle, and in the Webley and Crossman air rifles. The pellets are shaped like an hour glass, with a front section which rides on the rifling, a middle section, or "waist" of smaller diameter, and a flared rear section, or "skirt" which engages the rifling. This shape reduces the resistance of forcing the ball into engagement with the rifling, and permits the attainment of higher velocities.

These pellets have a hollow base, and the opening extends almost to the front end. Thus their weight is very small in comparison with their air resistance, and this gives them a very low "ballistic coefficient," which means that they lose speed very rapidly during their flight through the air. Actually they slow down enough to become harmless at a distance of 100 yards, and this fact makes them very useful for target practice and shooting around the yard and garden, as safety is assured if the user will only assure himself that all is clear for a distance of 100 yards in front of the gun.

The .177 pellet weighs 8.2 grains, and the .22 pellet weighs 15 grains. In the Webley pistol, interchangeable barrels may be had to shoot either size of pellet in the same pistol. As the energy delivered by the charge of compressed air is the same, regardless of which barrel is used, it follows that the .177 pellet will have higher velocity and penetration than the .22, but the latter will have more shock power when used against small animals, such as mice, etc.



Not a "firearm," but excellent for pistol practice. The Webley Air Pistol.

A .22 caliber B.S.A. rifle gives a muzzle velocity of 435 foot seconds, corresponding to a muzzle energy of 6.3 foot pounds. The Crossman air rifle, pumped up to six strokes of the lever, gives a velocity of 492 foot seconds or a muzzle energy of 8 foot pounds. With the Webley air pistol the .22 pellet gives a muzzle velocity of 273 foot seconds with a muzzle energy of 3 foot pounds, and the .177 air pistol tested by me gave 367 foot seconds velocity and a muzzle energy of 3 foot pounds. For the purpose of comparison, it may be stated that the muzzle energy of the .22 short is 54 foot pounds.

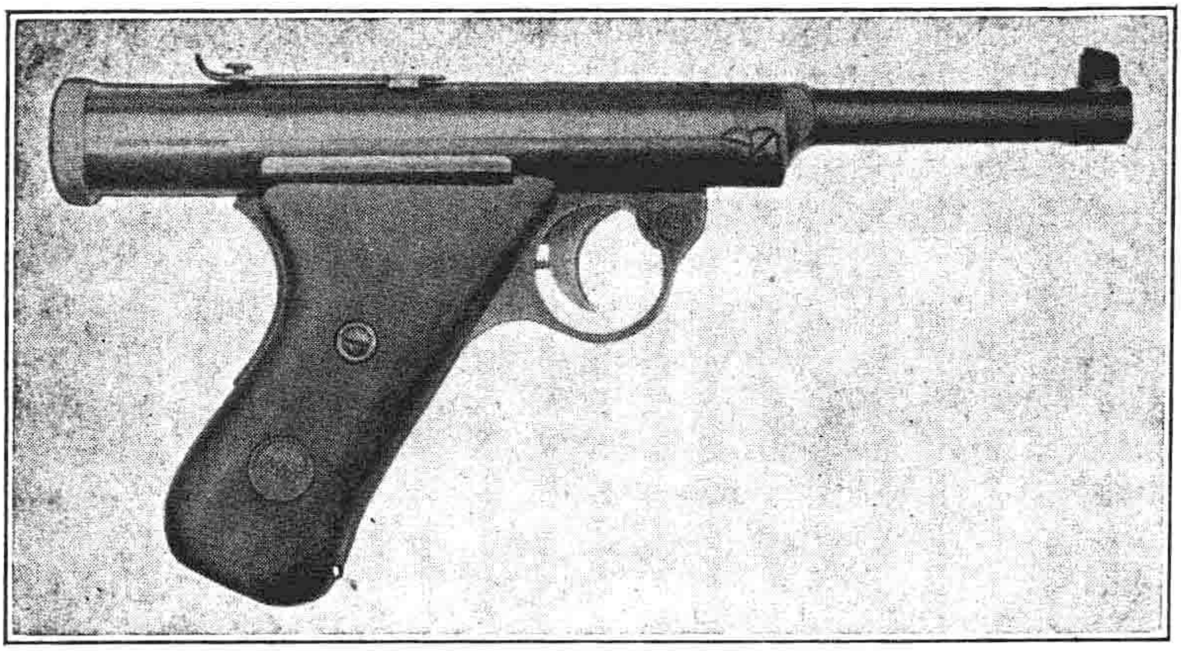
Of the several air pistols on the market, the Webley is perhaps the most popular. The handle and trigger are attached to the air cylinder, which lies just above the hand of the firer, and forms the main bulk of the gun. The barrel lies just above the air cylinder, and is hinged at the front end. By releasing the catch at the rear end of the gun, and lifting the barrel, the arm is cocked, through the action of a linkage connected to the barrel and connected with the piston through a slot in the top of the cylinder. Cocking involves drawing the air piston forward against the compression of a strong coiled spring contained in the front of the air cylinder. At the forward limit of its motion the piston is caught and retained by the sear. While the barrel is thus in the raised position, the pellet is inserted in the breech, and when the barrel is closed, the gun is ready to shoot. The Webley air pistol weights 2 lbs., has a seven inch barrel, and an adjustable rear sight. The barrel is rifled with seven grooves, right hand twist, one turn in 15 inches. The grooves are very wide with narrow lands between them. This adds to the velocity by reducing the force required to start the lands to cutting in the skirt of the bullet.

These Webley air pistols are very accurate, but they have a peculiar springy recoil due to the inertia reaction of the heavy piston which is driven backward in the air chamber of the gun when the trigger is released. The recoil is, therefore, negative; that is, the pistol tends to jump forward and downward slightly instead of backward and upward as in ordinary firearms. The recoil, while disturbing, is very much less in intensity than that in a regular firearm. With practice excellent shooting can be done with these guns in spite of the jump above mentioned, and I have seen a group shot at 25 feet distance that could be covered with a dime.

Another well known air pistol is the Haenel, made in two types, single shot and repeating. The single shot type sells for slightly less than the Webley, the repeating type for slightly more. These guns are shaped almost exactly like the Luger and are a very pleasant type of gun to aim but rather difficult to cock on account of the fact that the cocking is done by swinging the grip backward which affords a rather poor leverage for the work of compressing the spring.

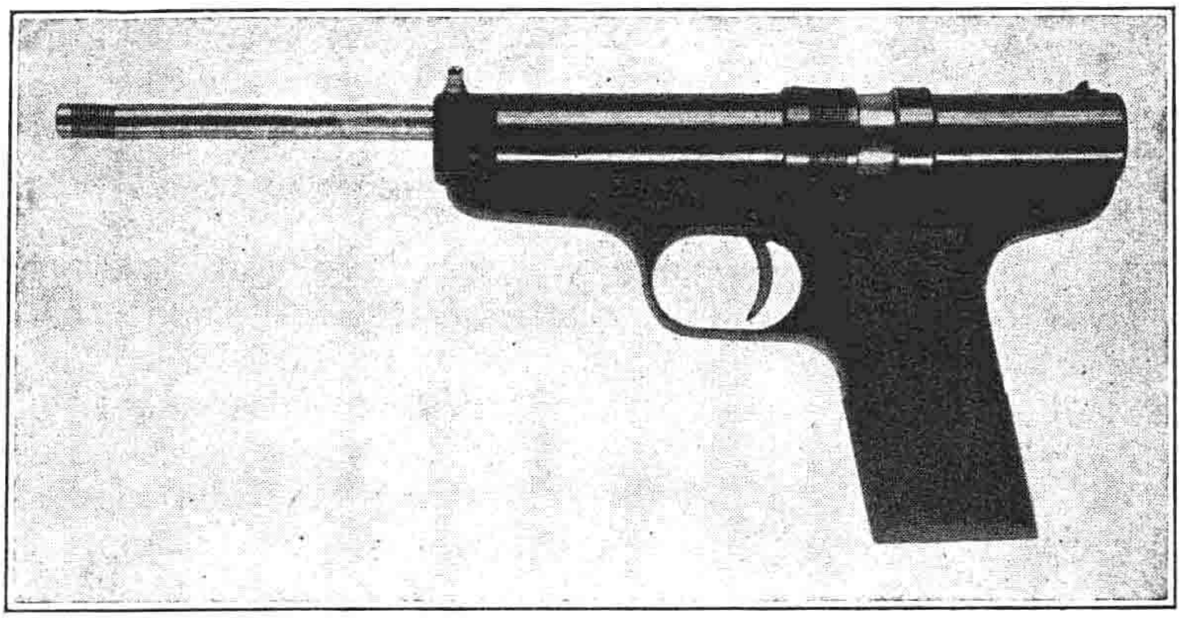
In these guns, the barrel is hinged to the frame, and may be tipped downward against the action of a spring detent to expose the breech for cleaning or loading. This action is entirely independent of the action of cocking the mainspring and air piston by using the handle as a lever. The Haenel Air pistol has a 4¼ inch barrel, with 12 lands and grooves of equal width, right hand twist, one turn in 18 inches. Weight, 2 lbs., 6 ounces.

A much cheaper air pistol, which does not shoot as hard as the Webley, but nevertheless is very satisfactory for target practice, is the Hubertus. In this gun, as in the Webley and the Haenel, the air cylinder lies over the handle, and contains the piston and the action spring. However, in this gun, the barrel lies in front of the air cylinder, and the cocking of the mechanism is accomplished by pushing in on the muzzle of the barrel. The breech end of the barrel is attached to a disc of steel against which the piston comes to rest when the gun is discharged. Pushing in on the barrel forces this disc against the piston, driving it back to the rear of the cylinder, against the main spring, which is compressed by this action. When the piston is cocked and caught by the sear, a lock can be released to allow the barrel and the forward part of the air cylinder to be tipped. This exposes the breech of the barrel, into which a pellet can then be inserted, after which the barrel is grasped by a corrugated portion near the muzzle, and drawn forward to its original position, the cylinder is tipped down



The "Haenel" Air Pistol. This gun, modeled on the shape of the Luger Pistol, is cocked by grasping the barrel with one hand and the stock with the other, and swinging the stock to the rear, first pressing the catch in front of the trigger guard. The barrel is then tipped down for the insertion of the pellet.

and latched, and the gun is ready to shoot. As a safety feature, the latch which unlocks the barrel so that it can be tipped down for loading also locks the trigger so that there is no danger of releasing the piston while the arm is open. Weight of the gun, 22 ounces. Barrel length 5 inches. Accuracy at 25 feet, a group of ten shots ¾ inch in diameter.



The "Hubertus Air Pistol." This inexpensive air pistol has a rifled barrel, and shoots the .177 air rifle bullets with very satisfactory accuracy. With the barrel extended as shown, the gun is in the firing position.

There are several other air pistols on the market, and all of them are useful for target shooting at short distances.

PISTOLS FOR SHOT SHELLS

Several different makers supply a single shot pistol chambered for the .410 gauge shot shell or the .28 gauge shot shell. Among these may be mentioned the Harrington & Richardson Handy Gun and the No. 35 Stevens Autoshot. Both of these guns are furnished in either 8-inch or 12¼-inch barrels and have a tip-up breech loading action.

The Harrington & Richardson catalog states in reference to the Handy Gun: "The sawed off shotgun has long been recognized as an extremely effective weapon at short range. The new Handy Gun is offered as a weapon of defense for the home, office and bank and as a small game gun for the hunter. Also for the automobilist for protection against holdups. When shooting in the dark or from a moving vehicle, making aim difficult or impossible, the spreading charge of shot has several chances of scoring as against one chance for a single bullet. A second shot can be fired very quickly, the automatic ejector throwing the fired shell clear of the gun."

Another weapon of the same category, but more powerful, is the Ithaca Autoburglar gun. This is nothing more or less than a 20-gauge double barrel shotgun, sawed off to 12¼ inches in barrel length and with the shoulder stock replaced by a pistol grip. The reason for the 12¼ inch length is that in some states the laws define a pistol as a gun with a barrel not over 12 inches in length. However, these laws are subject to constant change and it is not safe to rely on any such ruling.

A good example of the manner in which the firearms maker or user may be affected by the frequently changing legal requirements is afforded by the Federal Firearms Act of June 26, 1934. This law, which is intended to discourage the manufacture or sale of certain articles frequently used by gangsters, places a heavy tax on the manufacture or sale of the articles in question, and requires all owners of such articles to register them with the Collector of Internal Revenue. The articles affected are machine guns, mufflers or silencers for firearms, and any gun, except a pistol or revolver, which has a barrel length of less than 18 inches. The Harrington & Richardson Handy Gun has been decided to be a weapon within the meaning of this act, and in consequence, a tax of $200.00 must be paid whenever one of these guns is sold or transferred.

THE DIFFERENT MAKES

There are two firms in this country and one in England who are prominent among all makers of hand firearms in the world for the excellent design and high grade of their product. These firms are Smith & Wesson, of Springfield, Massachusetts, the Colt's Patent Fire Arms Manufacturing Company, of Hartford, Connecticut, and Webley & Scott, of Birmingham, England. All these firms manufacture both revolvers and automatic pistols.

Pocket automatic pistols of high grade were also manufactured by the Remington Arms Company and by the Savage Arms Company but have been discontinued by both of these firms, though Remington still makes a double barreled .41 caliber Deringer.

High grade super-accurate single shot target pistols and target revolvers of .22 caliber are made by the Harrington & Richardson Arms Company, of Worcester, Massachusetts. Pocket revolvers of .22, .32, and .38 caliber are also made by Harrington & Richardson as well as by the Iver Johnson Arms & Cycle Co. of Fitchburg, Mass.

CHAPTER 2

TARGET AND OUTDOORSMAN'S GUNS

TARGET shooting with the pistol or revolver is a sport which enjoys a large and rapidly growing popularity. Competition is vigorous and the great National Championships which are awarded every year are keenly contested. It is only natural, therefore, that the weapons intended specifically for use in this sport should be of the best possible design for the one purpose of getting the highest target accuracy. Sights, trigger pull, barrel length, etc., are determined solely from the viewpoint of the target range. For this reason the target weapon has a longer barrel, lighter trigger pull, smoother action and more delicate sights than have the military and pocket arms.

In the race for accuracy we might expect to see freak arms of all kinds used in target shooting, but this is prevented by certain definite rules by which our two great shooting organizations control the type of arm that may be used in their matches. For example, no barrel may be more than ten inches long; the sights must be not over ten inches apart; the trigger pull must be not less than two pounds for single shot pistols and two and one-half pounds for revolvers. These and other restrictions define pretty closely the general characteristics of the arm to be used, but within these rules the individual variations may be enormous as will be seen by referring to some of the illustrations accompanying this chapter.

Among the different types of gun that are used for strictly target work may be mentioned single shot pistols, automatic pistols and revolvers. The single shot pistol is capable of somewhat greater accuracy than is either the revolver or the automatic, and for this reason it is the finest of all target arms, and it is easier to make high scores with it than with the others. However, the revolver and the automatic are more practical arms than the single shot pistol, and, moreover, they are capable of very great accuracy; so great that some of the highest scores on record are held by the revolver. Therefore, to make the sport more interesting and varied, and to give the user of each type a chance for the title with his own particular arm, there are matches in which the revolver or automatic may be used and from which the single shot pistol is excluded.

The different varieties of target arm will now be described.

SINGLE SHOT TARGET PISTOLS

The single shot target pistol is a very fine type of gun for the man who is just starting to learn shooting. One reason for this is that it is much safer than either an automatic or a revolver. A single-shot pistol which must be reloaded after every shot and which remains empty most of the time, is the arm to start off with. In using the revolver, and even more in using an automatic pistol, there is a natural tendency to shoot too fast and to fire too many shots, because it is so easy to go ahead and shoot.

The single-shot pistol must be reloaded after each shot, which rests the user between shots and allows him to gain familiarity with the action by the repeated handling thus made necessary.

This arm is also free from the danger sometimes present when a beginner starts with an automatic pistol. This is the danger that he may become rattled and pull the trigger again unconsciously, thus firing another shot. This can not happen with a single-shot pistol and even if the weapon should be dropped upon firing, no harm is done. Moreover, the single-shot action is easier to clean and keep in proper condition than the six shooter or the automatic.

Another reason why this is a good gun for the beginner, is the fact that it shoots the .22-caliber cartridge which is economical and does not have a serious recoil and report to confuse the issue of learning to shoot.

Stevens Target Pistols

Many years ago the J. Stevens Arms & Tool Company of Chicopee Falls, Massachusetts, began to make target pistols, and in the days of Paine and Bennett these arms became celebrated. Their popularity continued until about 1904 or 1905. They were made in several weights; the heaviest being known as the Lord model, with a very massive barrel; the Conlin model, with a finger spur, and the Gould model, were somewhat lighter; and the Diamond model was the lightest of all. These guns were all of the "tip-up" variety, opened by pressing in a button on the left side. The front sight was a bead, or "Paine" type; the rear sight was a round notch on a flat spring adjustable for elevation by means of a serrated wedge. There was no adjustment for windage except by driving the rear sight to one side or the other in its slot with a hammer. These sight adjustments were very crude indeed as compared with the modern screw controlled sights which are fitted on all first class target pistols today. In these old Stevens pistols the hammer had to be put at half cock before the action could be opened or shut; otherwise the firing pin interfered with the end of the barrel. These guns were years ahead of their time in the matter of size. Though they were made in .22 caliber, they had a full man sized grip, which no other American .22 caliber arm did until very recently.

The first target pistol ever owned by the writer was a Stevens Diamond model and much ammunition was burned in it. None of these old guns are now made, but the company still produces a gun very much like the old Gould model, and with the same action. This is called the "Off-hand Model" or the "No. 35." This gun is furnished in 6″ and 8″ barrel only and is also made for shot shells in .410 caliber.

The Stevens No. 10 Target Pistol

After the World War, Stevens produced a new model, looking like an automatic, and having an improved rear sight, adjustable for windage and elevation. The barrel tips up to load, and is held shut by a lock on the left side. This lock is cam shaped so that it automatically takes up any play and prevents looseness from developing. This gun is what might be called semi-hammerless. The hammer is enclosed inside the frame, but has a rod with a knob on the end of it by which it may be cocked.

This is an extremely well balanced gun which feels quite comfortable in the hand. The trigger pull is excellent. In this modern gun the Stevens Company has lived up to its old time reputation for accuracy, as these No. 10 pistols are capable of making 1¼ inch groups at 50 yards from machine rest. Barrel length, 8 inches. Weight, 36 ounces.

The Smith & Wesson Perfected Target Pistol

For many years the Smith & Wesson Perfected Target Pistol was the outstanding arm in its class and enjoyed almost a complete monopoly of the favor of the great target shots. Its popularity was deserved, for it had unexcelled accuracy and superb lockwork, and year after year the winners in the big matches would be found using this gun. It originated as an extra barrel for the Smith & Wesson .32 caliber single action revolver. This revolver had a hinged frame with a tip-up action, and at one time the company marketed a combination set consisting of the .32 caliber revolver and an extra single shot barrel which could be put on the revolver frame by taking out the joint screw and removing the barrel and cylinder and inserting in its place the single barrel. With the target barrel in place the appearance of the gun plainly indicated that it was intended primarily as a revolver, for the revolver has a lip on each side of the frame to back up the cartridges in the cylinder, and when the single shot barrel was in place these lips of course remained on the frame, giving rather an odd look to the gun.

As the single shot feature became more popular the company marketed the single shot pistol alone and the lips on the frame were omitted. The lock-work was of the single action type, which, of course, is all that is needed on a single shot target pistol. This gun was known as the Model of 1891. Finally, some years later, Smith & Wesson designed a new lock-work for their double action arms and as this was thought to give a more perfect trigger pull, it was incorporated in the target pistol, although of course there was no need for the double action feature of the lock-work. This gun was designed to take full advantage of the rule regarding barrel length and distance between sights, so the barrel is exactly ten inches long and the distance between sights is ten inches. The gun weighs twenty-five ounces and the barrel tips up to load.

Frequently someone familiar with pistol shooting may be heard to speak of the "Olympic Model" Smith & Wesson .22 and it may be well to explain the meaning of that term. At the time of the Olympic Games in 1920, Mr. A. L. Woodworth of the Springfield Revolver Club, who is also an experimental engineer at Springfield Armory, made a number of experiments with .22 caliber rifling and determined that the bore of the Smith & Wesson single shot pistol, which was .226 in diameter, was slightly too large for the very highest possible accuracy. After a number of experiments it was found that a .223 bore and a very tight chamber with the rifling extended back so that it would cut into the bullet when the cartridge was inserted in the chamber would give considerably improved accuracy. Ever since 1921 this construction has been standard with Smith & Wesson. T. K. Lee called the gun with the new bore and chamber the "Olympic" .22 because they were used to equip the Olympic Team of 1920. As often happens in such cases, the name stuck to the gun and the Smith & Wesson pistols made with this smaller bore are called the "Olympic" Smith & Wesson to distinguish them from the older ones. In using this Olympic Smith & Wesson it will be noted that the cartridge cannot be pushed all the way in the chamber but stops when it is about a sixteenth of an inch from being all the way in. This is where the rifling comes against the lead bullet and at this point an additional extra pressure must be put on the cartridge to force it home.

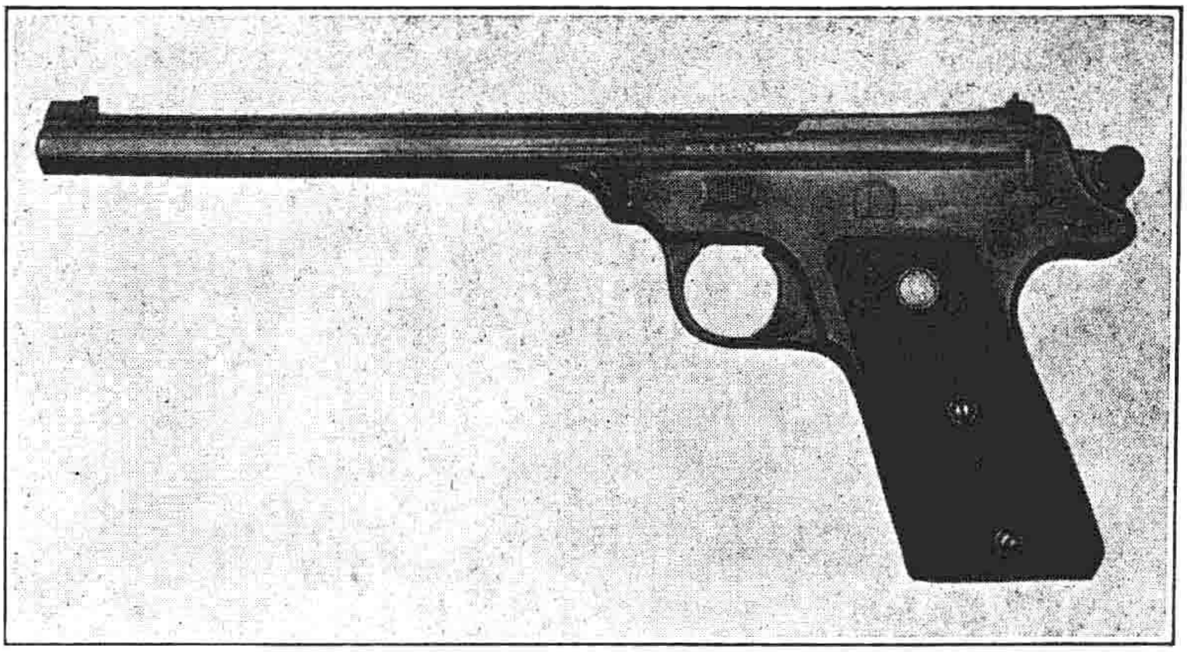
While this arm perhaps holds more target records than any other pistol that has ever been designed, it is of course by no means perfect. In the first place the gun was built with the receiver of a small .32 caliber revolver as a foundation. The .32 caliber frame has a handle that is not large enough for the hand of the average target shot and to overcome this difficulty large wooden grips were fitted over this small handle. However, the relation of these target grips to the trigger is influenced by the small size of the frame to which they must be fitted and for this reason the grip on this pistol has never been entirely satisfactory; one of the worst disadvantages being that there is not enough space between the frame and the back of the trigger guard to accommodate the middle finger. The difficulty encountered with the grip of this gun is reflected by the fact that many users either make special grips or build up and pad out the regular ones in some way.

In spite of the disadvantages above mentioned this Smith & Wesson perfected target pistol was for many years the stand-by of the match shots in the "Any Pistol Class" and for years was the standard target arm. The barrel is superbly accurate. Groups of less than an inch in diameter at fifty yards have repeatedly been made from machine rests with this gun. In using this pistol keep the joint screw well tightened up, otherwise looseness may develop between the frame and the barrel which will have a bad effect on accuracy. Also when closing the gun be sure that the latch is pressed down firmly as the rear sight is carried on the latch and unless this precaution is observed variations in elevation may occur. The manufacture of this gun was discontinued in 1923 on the advent of the Straight Line Target Pistol.

Smith & Wesson Straight Line Target Pistol

Smith & Wesson had long recognized the disadvantages mentioned above as applying to the Perfected model, and in 1923 they brought out a new model which was called the Straight Line Target Pistol, the result of an earnest and very commendable attempt to produce an up-to-date and highly improved target gun which would eliminate the disadvantages of their former model. In producing this arm the great Smith & Wesson organization started in from the ground up to design a gun which would be solely and entirely a single shot target pistol with every feature determined only by the requirements of target shooting. To begin with, none of the older models were considered in making this new gun and it was not built on the receiver of any other arm as a foundation as was the previous model. Instead the handle was first designed to as nearly as possible fit the hand of the average shooter. This handle was made of a typical automatic pistol shape and was given the proper slant so that when the arm of the shooter is extended the barrel of the pistol will point horizontally.

Then after the handle was decided on the design was further completed so as to place the barrel of the pistol as close down to the line of the shooter's arm as possible. This barrel was of course made ten inches in length and was bored and rifled exactly as was the old Olympic model which has never been improved upon for inherent accuracy. The barrel was fitted to swing sideways for loading and both front and rear sights are mounted on the barrel itself so that there is no chance of relative motion between the sights as is the case when the front sight is mounted on the barrel and the rear sight on the receiver of a jointed frame pistol. The firing mechanism is an innovation in that the usual swinging hammer is discarded and for it is substituted a striker moving in a straight line parallel with the barrel.



The Smith and Wesson Straight Line Target Pistol.

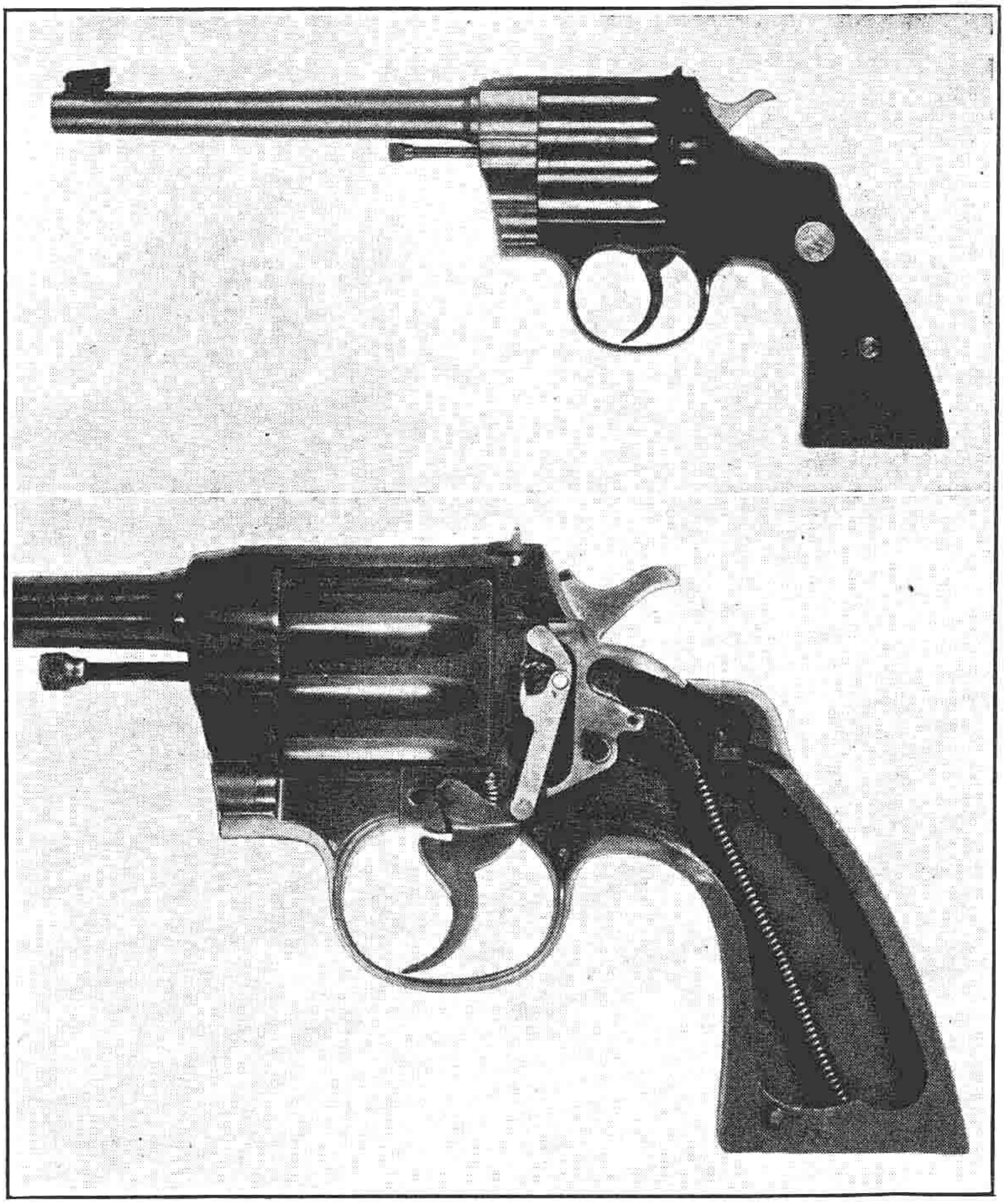
The distance between sights is 9¼ inches, and the rear sight is adjustable for both elevation and windage. The elevation screw has a "click" for every half turn, which prevents the adjustment from accidentally becoming changed. The number of threads, 40 per inch, on the elevation and windage screws, and the distance between sights, has been so chosen that one turn of the adjusting screw will move the shot group one inch on the target for each ten yards of range. For example, at twenty yards, a turn of the screw will move the group 2 inches, and a half turn will move it one inch. The pistol weighs 34 ounces, and is put up in a pressed steel case with a ramrod and a screw-driver.

It is a peculiar and unfortunate thing that this Straight Line Pistol has never attained anything like the same popularity that was enjoyed by its predecessor, the old Perfected Model. This is to be regretted because shooters are often to be heard blaming the companies for ultra-conservatism and for being afraid to put money into production of a new model. Certainly it is to the shooter's advantage when a company does bring out something new and improved but it costs the company a great deal of money to do so and when after such an effort the company finds itself losing money and realizes that the new model is not as popular as the old one then it does not help to get any more improvements adopted.

It has always been somewhat of a mystery why the Straight Line did not take with the shooting public as well as did its predecessor; but the fact remains that it is easier to make good scores with the old Perfected Model with all its disadvantages than it is with the Straight Line with all of its supposed improvements. There is not the slightest doubt in the world that the Straight Line Pistol has a superbly accurate barrel, but something about the design makes it somewhat hard to get out of this gun all the accuracy that it possesses. My own opinion is that it is probably due to the fact that the reach to the trigger is too short. When I shoot this gun the trigger comes on the second joint of the index finger and it is difficult to let-off a trigger with this part of the finger without losing some of the necessary sensitiveness and control. Moreover, the angle of the grip is such that the barrel has a distinct tendency to point downward when the arm is extended naturally toward the target. This means that there is always a constant, though perhaps imperceptible, effort expended in keeping the barrel brought up into the proper line, and there is always a tendency for any relaxation or twitching to cause a low shot.

The Colt Camp Perry Model

For many years nearly all the leading slow fire shots in the "Any Pistol" class used the Smith & Wesson Perfected Target Pistol, and there was no other target pistol to be had which was at all comparable with it; while in the revolver class there were highly satisfactory target arms made by both Smith & Wesson and The Colt's Patent Firearms Manufacturing Company. With many revolver shots the Colt guns, such as the Officer's Model .38 and the New Service Target .44 were favorites. Many of these shooters repeatedly urged the Colt Company to produce a single shot



Upper: The Improved Colt's Camp Perry Model Single Shot Target Pistol. This gun has the same grip and is built on the same frame as the Officer's Model Revolver in the .22 and .38 Calibers.

Lower: The Colt Camp Perry Model .22 Caliber Target Pistol with the grip and side plate removed to show the simplified single action mechanism. The lever on the left operates the Positive Lock, a safety Device to prevent accidental discharge in case the gun is dropped or the hammer receives a blow from any cause.

target pistol also. Finally, at the National Matches of 1921 a few members of the Marine Corps team were observed to be shooting a new .22 caliber single shot target pistol made on the same frame as the Officer's Model .38. The cylinder of the revolver is replaced by a flat block containing the breech end of the barrel. This block, carrying the barrel is hinged to swing to the left for loading just the same as the cylinder in the revolver does.

This new gun had something that the shooters of the country had long been demanding, which was a .22 caliber target arm with a full sized frame. It seems self-evident that the size and shape of the grip on any pistol or revolver should be determined by the average size of the hands of the users; but strangely enough pistol and revolver manufacturers had for years seemingly determined the size of the handle on any gun by the size of the cartridge the gun was intended to shoot. For all .22 caliber guns were made on a tiny frame with a tiny handle, suitable for a race of men about three feet tall; the .32 calibers were made on a small frame with a handle about right for a race of men about four and one-half feet tall. Only the larger guns such as the .38 specials and the .45's had grips about right for the present race of humans.

The new Colt pistol was called the Camp Perry Model. It had a ten inch barrel, ten inch sight radius, and a fine large grip with a very favorable balance and a weight of 34 ounces, which is about right for a target gun of this kind. Though the gun exactly resembles the revolver in outside appearance, the lockwork is entirely different, being simplified as much as possible and especially constructed for a clean, crisp trigger pull and fast hammer action. In the Spring of 1934 the gun described above was superseded by a new and improved model, with an eight inch barrel instead of the ten inch barrel formerly used, and with a shorter hammer fall and consequently faster lock time. The new model also has the barrel increased slightly in diameter so as to retain the weight and balance. Moreover the trigger has been redesigned so as to be more slender and not so curved.

This is an excellent single shot pistol and will appeal especially to the revolver shot, for this gun has the same weight, appearance, grip and balance as the target revolver, so that matches shot with this gun serve as practice for the revolver, and vice versa. The reader will note, perhaps with surprise, that this gun now has a barrel shorter than the full ten inches allowed by the rules. In past years target pistol shots assumed as a matter of course that the best accuracy would be obtained by using the longest possible barrel allowable; but recently a conviction, shared by the author, that a shorter barrel frequently gives better results, has been gaining headway.

The Harrington & Richardson U.S.R.A. Model

This is the most popular target pistol on the market today. In fact, it now holds the pre-eminent position in the "Any Pistol" class that was formerly held by the Smith & Wesson Perfected .22; and the rather strange thing about this fact is that the company that produces this gun has until recent years specialized in very inexpensive revolvers and shotguns and has never, until lately, entered the target shooting field.

Though, as mentioned above, the company made only very inexpensive guns, they had a large trade and a capable management, and all that they needed to be a factor among the makers of target arms was a clever designer with an intimate knowledge of the target shooting game and a management with sufficient breadth of view to take advantage of his knowledge. The designer they found in the person of Mr. Walter Roper, and they already had a manager with broad vision in the form of Mr. John M. Harrington. This combination has enabled the firm to take a position second to none in the excellence of their .22 caliber target weapons.

When this company first decided to go into the single-shot pistol game they were somewhat fortunate in being able to approach the problem from an unprejudiced viewpoint, because it was a new line to them and they did not have any model which was suitable for working over into a single-shot pistol. Thus, they had to start from the ground up, and therefore they were enabled to make their model to fit target pistol requirements as they saw them, without any factors of expediency to influence their decision.

With any single-shot pistol there are two factors that enter into the size of groups to be obtained. One is the mechanical accuracy of the gun itself, and the other, and by far the more important one, is the personal accuracy of the user. This factor that I have called "personal accuracy" depends upon several things, but assuming that a man is what is generally known as an excellent shot, and that he knows all about aiming and sighting, holding and trigger pull, still there is another factor that enters very strongly into his ability to perform with a pistol, and that is having a gun which will actually fit his hand and enable him to take a comfortable shooting stance; in other words, having a gun whose shape, balance and grip will do their maximum in helping the shooter to do his best.

Usually the errors of the shooter are so much greater than those of the gun, that I sometimes think this factor of fit and balance is the most important of all for a single-shot pistol.

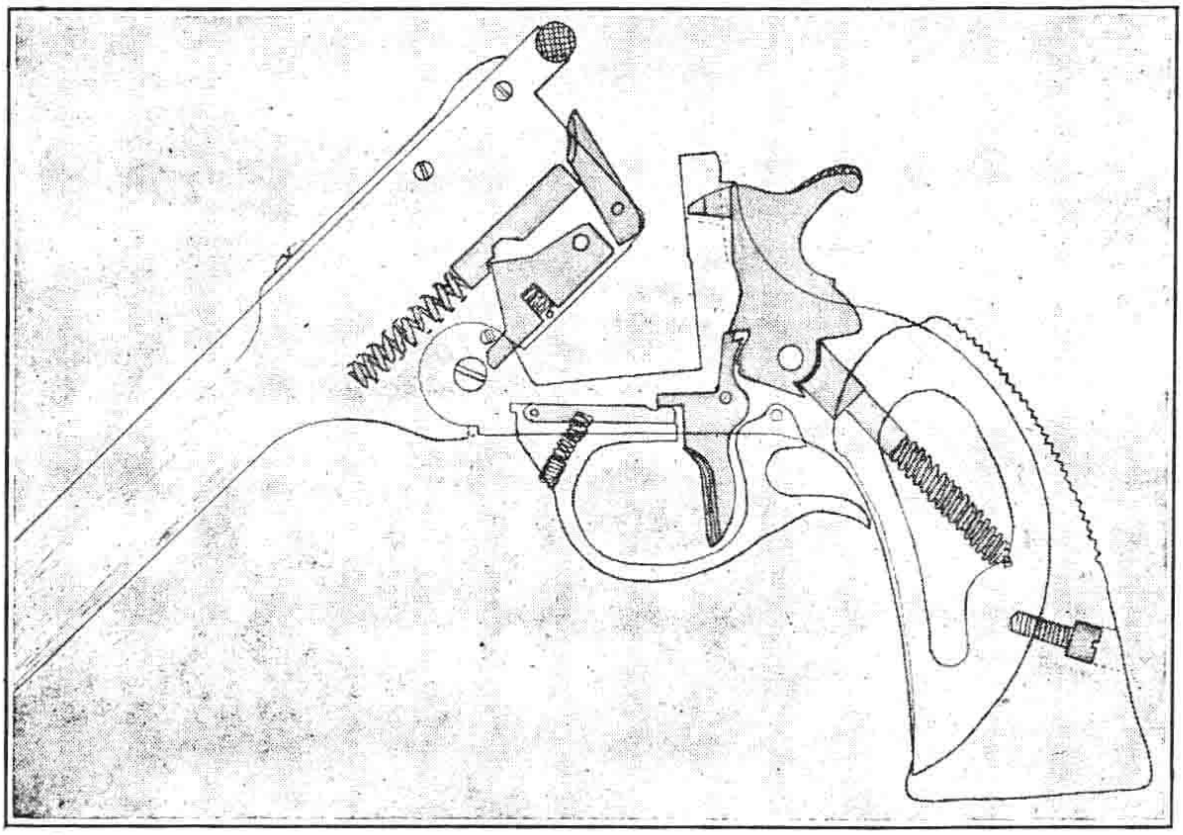
In the past the unsuitable grip or handle on most of the single-shot pistols available has been a source of a great deal of dissatisfaction. One of the very finest target pistols hitherto available originated as a combination set consisting of a small revolver and an additional single-shot pistol barrel to be put on after removal of the revolver barrel and cylinder. In this gun the grip was entirely too small. As an expedient to overcome this trouble a special target grip was furnished to slip over the revolver frame, and this helped considerably, but still left a great deal to be desired, as the space between the trigger guard and frame was too small and narrow to accommodate the middle finger of the right hand, which would naturally go into this space on gripping the pistol. Many shooters found it necessary to fill this space up with a wooden block or with a piece of soft rubber, or some other filling material.

Now Walter Roper knew all these things very well and he decided first, to find a way to produce a pistol barrel with the finest possible mechanical accuracy; and second, to build this super-accurate barrel into a target pistol with a grip that would fit John Shooter as he is without the addition of gadgets, padding fastened on with tire tape, special stocks, or anything of the kind. The remarkable thing about this whole business is how well he succeeded.

From his experience in the arms business, Mr. Roper believed that the best way to develop really fine accuracy in the first place and to keep it that way in the later manufacture is to use a machine rest that will eliminate the human factor in testing for that accuracy. For years it had been considered almost impossible to make a really reliable machine rest for pistols and revolvers, and it still is something that has never been satisfactorily done for the larger calibers; but it can be done for the .22, and Mr. Roper proceeded to do it.

With the aid of the machine rest the accuracy of the barrel was developed to the point where all shots touch at 20 yards, and one inch groups at 50 yards are the rule. Moreover, this machine rest is used in a routine way in the factory for the regular production of guns, and each gun made is tested on the machine rest and must perform satisfactorily or it will not be accepted.

Having thus conquered the question of accuracy, the matter of grip and fit remained. It was observed that most shooters fill up the space behind the trigger guard, so a projection was provided on the trigger guard to fill this space and provide a surface to rest on the middle finger. Then the metal frame of the handle was so designed that the machining necessary to make a piece of wood fit on this frame was reduced to a minimum and could be done very cheaply. Thus the company was enabled to furnish several different shapes of wooden grips all adapted to be used on the same gun, so that the user would be sure to find a grip to his liking, without having a special one made up. Five main shapes of grips are furnished. No. 1 is the regular grip like the one shown in the sketch. No. 2 is somewhat thicker and fatter. No. 3 is similar to No. 2, and in addition has a lip projecting upward at the top of the grip behind the hammer to keep the hand from slipping up on the grip. No. 4 is shaped somewhat like the handle of the old single action Colt revolvers. No. 5 is the so-called Free Pistol type with the bottom of the grip extended well to the rear. There is also one called No. 3-No. 5 which is a No. 5 grip having at the top a lip like that on the No. 3 style.



X-ray sketch by the author to show the mechanism in the latest U.S.R.A. Model Harrington & Richardson Single Shot Pistol. Note the double point on the trigger. One point is used for the full cock position, which does the fine work of shooting, while another point is used for the half-cock notch, which has to do the heavy work of keeping the arm safe. The screw in front of the trigger guard will change the weight of the trigger pull.

One of the most important innovations in this gun is the lock-work. Previous single-shot pistols, especially those based on revolver design, usually have quite a long slow hammer fall, as compared with this one. A long hammer fall has a very bad effect on scores because it gives time for the gun to move after the trigger has been pulled and before the cartridge explodes. A heavy hammer is bad because it jars the gun and sets up vibrations which affect the bullet delivery from the barrel.

In designing the lock-work for this gun, the makers did not take a revolver lock and readapt it, but started out all new and designed a non-jarring speed lock with extremely short hammer throw, which makes it lightning-fast. The lack of jar in this lock-work is really remarkable. The makers recommend placing a dime on the front sight and then trying to snap the gun without displacing the dime. This is an extremely difficult test, but it can be done.

The accompanying X-ray drawing shows the lock-work used in this gun, and it will be observed that it differs remarkably from the common revolver type of lock. It will be observed that the lock-work is extremely simple, which conduces to an excellent trigger pull. Moreover, the trigger pull is easily reduced by stoning in case it is desired to use the gun for free-pistol shooting.

Among the other mechanical improvements on this gun, not the least important is the fact that the frame closes up absolutely tight so that the head of the cartridge is fully enclosed, and thus there is no danger of having the heads blow out and cut the firer's fingers, as has happened in the past, and which is still more likely to happen with the new high-speed ammunition. Incidentally, it may be mentioned that this H. & R. gun is safe for use with this new ammunition.

In some guns the mistake has been made of having the striker or hammer nose hit that part of the cartridge which rests on the extractor. This is a bad mistake, as caliber .22 ammunition is notoriously sensitive to changes in ignition, and anything that tends to cushion the hammer blow will adversely affect the accuracy. In this U. S. R. A. Model, this mistake was carefully avoided, and the part of the primer that is hit is held solidly against the frame.

The sights are of the Patridge type, and both are mounted on the barrel so there is no chance of misalignment, as there is when one sight is mounted on the barrel and the other on the frame. All adjustments are made on the rear sight, which is adjustable for elevation and windage by means of a fine screw adjustment made with a screw-driver. Making both adjustments on the rear sight removes a possible cause for confusion when one adjustment is made on the rear sight and the other on the front sight, because the rear sight must be moved in the same direction as the desired change, whereas the front sight must be moved in the opposite direction.

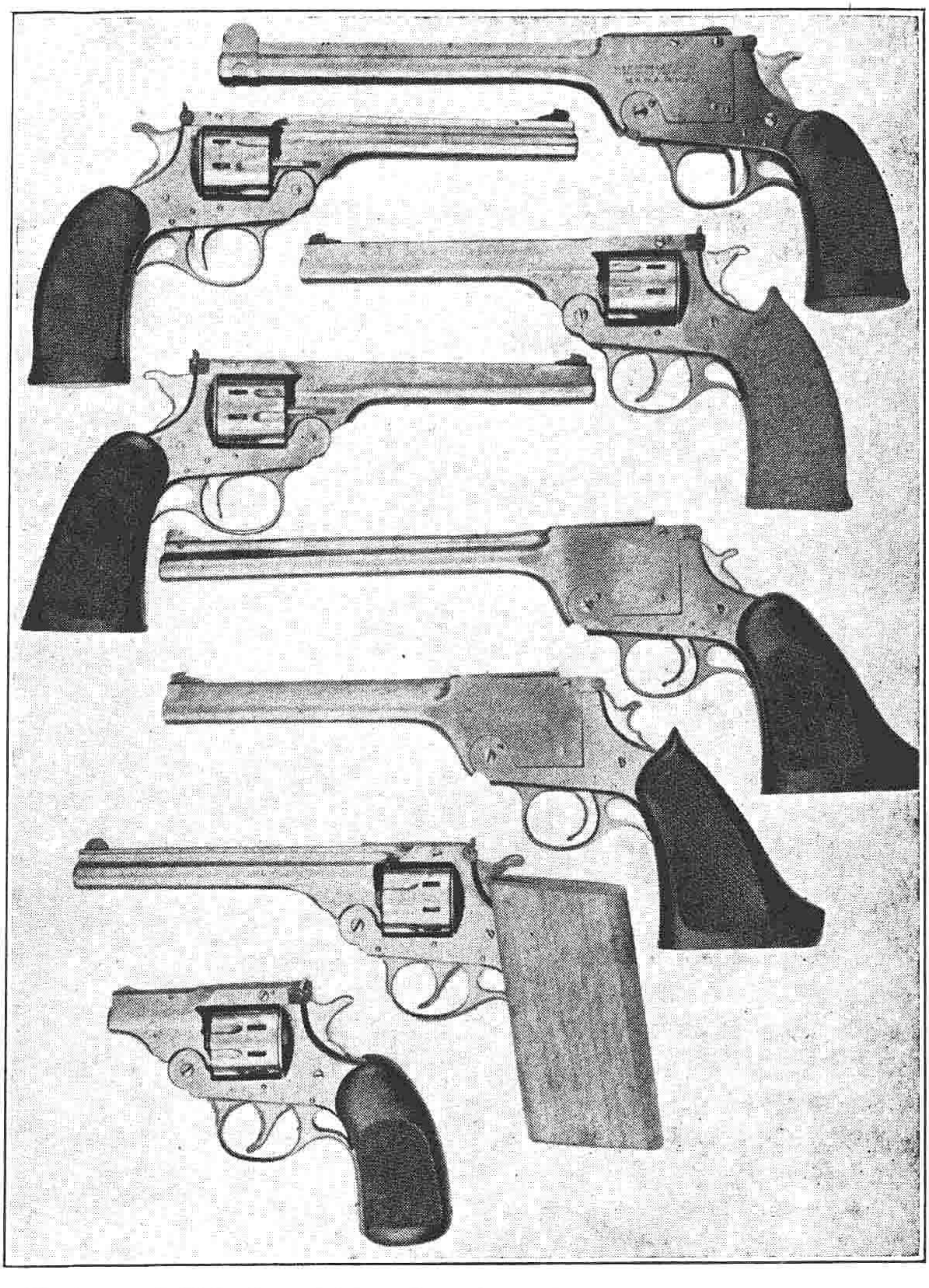
The ejector on this gun is automatic. Once you open the breech the cartridge is thrown out with considerable force. The action of the automatic ejector is also shown in the X-ray sketch.

The description given above applies to the early models of this gun such as were produced early in 1931. There have, however, been numerous changes, as the company has constantly followed the performance of their guns among the shooters, and when any trouble or criticism has been encountered, there has been an earnest attempt to correct it, and many changes have been made since the original models were produced. Most of the changes actually do improve the gun, though in the author's opinion the older models were better in some respects.

For example, in the later H. & R. single shot pistols the hammer is made much larger and heavier, which makes it easier to get hold of, but also makes it slower and causes it to jar the gun more when it falls. This change was a mistake; the old hammer is preferable. In the later models the trigger is made straight, instead of curved. Theoretically this should be an advantage as it allows the finger to be placed low on the trigger so as to get more leverage and make the gun fire more easily; but in practice I like the old one better as the curve fits the finger and brings it to the same place every time.

The lockwork has been much improved as to durability by redesigning the hammer and trigger so that the rebound notch in the hammer rests on a special shoulder on the trigger, and not on the sear point that releases the hammer in shooting. Thus the heavy work of keeping the gun safe in case of a blow on the hammer as in letting the gun fall, etc., is taken away from the sear, which never has any work to do except to release the hammer in actual shooting.

One thing about this gun that sometimes causes trouble is the ejector. It is of the spring type, as has been described above, and is so arranged that when the gun is opened, the cartridge is thrown clear. Ordinarily this ejector works admirably, and when it is working well it is extremely convenient; but it sometimes happens that a cartridge will stick in the chamber of the gun too tightly for



Harrington & Richardson pistols and revolvers with the interchangeable stocks furnished by the makers. From top to bottom, 10 inch pistol with No. 1 stock. Single action Sportsman Revolver with No. 2 stock. Double action Sportsman revolver with No. 3 grip. Single Action Sportsman with No. 4 stock, the best for this gun. 10 inch pistol with No. 5 stock. 8 inch pistol with No. 3-5 stock—the author's favorite combination for high scores. Double action Sportsman with rough wood block to be shaped by the purchaser. New Defender with modified No. 2 stock, the best for this model.

the spring to start it loose; and then when the gun is opened, nothing happens, and the gun is entirely out of action until a cleaning rod can be obtained with which to push out the empty shell.

Another thing that has caused me a considerable amount of trouble—in fact I should say more trouble than anything else, and the only real trouble I have ever had with the H. & R.—is the rear sight. In some of the early models the rear sight is made of very soft steel and after the sight is adjusted for elevation and the gun is all targeted in it is somewhat of an annoyance to have the adjustment entirely destroyed by the bending of the rear sight due to some slight pressure or blow against some other object. The later models have an improved rear sight, but again I do not like the improvement as much as I do the original and would rather put up with the bending than to use the shape that I do not like.

This Harrington & Richardson target pistol was originally made with a ten inch barrel; but in 1931 Walter Roper got to experimenting with shorter barrels, as he thought that they would be steadier when shooting in a wind outdoors. He made up an eight inch barrel model and found that it was not only steadier, but that the sights appeared clearer, as the eye can more easily focus on two sights that are close together than on two that are far apart. In addition he thought that the short barrel had a favorable psychological effect on the shooter because it does not magnify the tremor of the hand or any inaccuracies of holding quite as much as does the longer barrel. He wrote to me about this and asked my opinion, and in addition he sent me one of the eight inch guns to try out. It so happened that this gun arrived just before I was due to leave for England as Captain of the American Rifle Team competing at Bisley that year and as sort of an afterthought I threw the gun into my trunk and took it along.

The gun had a No. 5 grip which was the first of that type that I had ever seen as it had just been evolved from somewhere in the recesses of Walter Roper's head a week or so before. With this new grip and short barrel the gun seemed to balance exactly right and Ensign Harry Renshaw, the Coach of the Team, went with me when we tried it out on the range at Bisley and we both shot such good scores with it that we decided to target the gun in for twenty yards and enter the pistol match. To everybody's surprise including my own I was fortunate enough to win the match with a perfect score of one hundred and Harry won second place with a score of ninety-eight. The gun excited a great deal of interest and we allowed as many of the British to use it as wanted to and some of them shot very high scores with it in the match.

On my return to Camp Perry that year I used this gun in Match B of the U. S. R. A. and while I did not make a particularly high score in the full fifty shot match, I did have one ten shot target of ninety-seven, three shots being just barely outside the bottom edge of the ten ring. This was of course at fifty yards on the standard American target.

I have two ten inch Harrington & Richardson pistols, one of an earlier model made in 1931 and one of the latest models; and I repeatedly tried these guns out against the eight inch gun and my scores always run slightly higher with the eight inch barrel.

As a result of the success of the short barrel gun in this and other matches, Harrington & Richardson regularly supply a seven inch barrel model when desired. The reader will note that the gun that I used and still use is an eight inch gun whereas the model supplied commercially is of seven inch length. I do not place any importance on the difference of one inch; as far as I can tell the seven inch and the eight inch models shoot about alike. It is undoubtedly true that the longer barrel gives the theoretical advantage of a longer sighting radius and consequently closer sighting on the target; but quite evidently the clearer definition of the sights in the shorter model makes up for its lack of sighting radius.

From what has been said above the reader may be inclined to think that I would always recommend a seven inch or eight inch barrel as against the usual ten inch; but I am frank to say that many excellent shots, and perhaps the majority of them prefer the usual ten inch barrel and seem to get better results with it. However, as the target shooting world is learning that the shorter barrel has certain distinct advantages and capabilities of making the very highest scores, there is apparent a distinct trend towards short barrels and away from the long barrels formerly in vogue. For example, in 1934 the Colt Patent Firearms Manufacturing Company reduced the barrel length of their Camp Perry model to eight inches and of their Woodsman model automatic from 6½ inches to 4½ inches. As mentioned above, all of these Harrington & Richardson pistols are targeted at twenty yards in the factory using a machine rest; and no pistol is accepted unless all five shots cut a circle ¼ of an inch in diameter. The writer has spent quite a bit of time watching these machine rest tests at the H. & R. factory and can state from personal observation that the average pistol, just as it comes to the tester will more than meet the requirements. At fifty yards the average accuracy of twenty regular pistols taken from stock with all makes of ammunition was such that a circle .65 of an inch in diameter would pass through the centers of the most distant shot holes of the five-shot groups.

I have never asked the company what their standard bore and groove dimension is; but I did measure one of my own guns with very great accuracy and for my own information I compared the figures with the dimensions of the super-accurate Vickers match rifle and with those of a Springfield .22. The results are:—

	H & R	*Vickers*	*Springfield*
Groove Diam.	.2175	.221	.2230
Land Diam.	.2141	.2188	.2180
Depth. Groove	.0017	.0011	.0025
Width Groove	.0835	.0737	.0854
Width Land	.0304	.0420	.0897
Area of Bore	.0369	.0381	.0381

The weight of the gun is 31 ounces with ten inch, 28 ounces for the eight inch and 26½ oz. for the seven inch barrel.

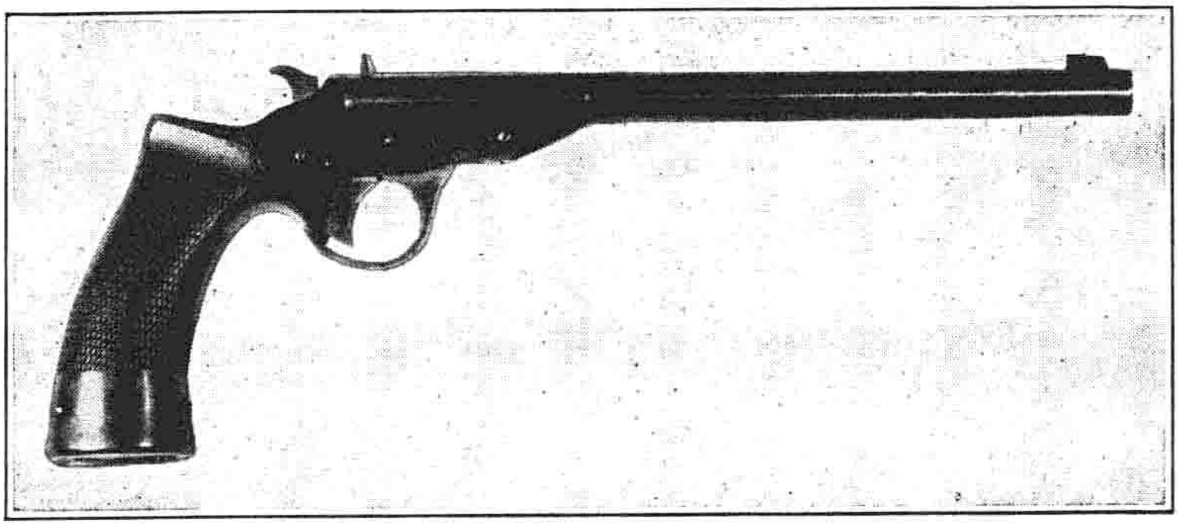
The rear sight is adjustable for both windage and elevation. The shooter will be interested to know how much the shot group will move on the target for a half turn of the rear sight screw. This of course depends on the sight radius and the distance to the target as well as on the amount the sight moves when the screw is turned. The ten inch barrel gun has a sight radius of 9.2 inches, the eight inch barrel, has a sight radius of 7.2 inches, and the seven inch model has a sight radius of 6.2 inches. The elevation and windage screws have eighty threads per inch, but this does not mean that the sight moves only 1/80 of an inch for a turn of the screw because the sight screw acts with a leverage so that the sighting part of the rear sight moves more than the part where the screw is attached. Actual measurements on several models show that the sight moves side-ways .020 inches for each turn of the windage screw and raises .023 inches for each turn of the elevating screw. The table given below shows the amount in inches that the shot group will move on the target for each turn of the elevation and windage screws. These figures were obtained by calculation and checked by actual firing.

	10" Barrel		*8" Barrel*		*7" Barrel*	
Range	*Elevation*	*Windage*	*Elevation*	*Windage*	*Elevation*	*Windage*
25 feet	.69	.60	.88	.77	1.02	.89
10 yards	.84	.73	1.07	.93	1.24	1.07
15 yards	1.29	1.11	1.65	1.43	1.91	1.65
20 yards	1.74	1.51	2.22	1.94	2.56	2.25
25 yards	2.19	1.90	2.80	2.43	3.25	2.82
50 yards	4.44	3.85	5.65	4.95	6.56	5.74

In making up this table, the range used for the calculations was in each case two feet less than the nominal range. This was done to compensate for the fact that in target shooting the stated range is the distance from the feet of the firer to the target, and the sights of the gun are about two feet closer to the target. This is why, for example, the figure given for 20 yds. is not exactly twice the 10 yard figure.

The Webley & Scott Single Shot Target Pistol

This pistol has a ten inch barrel with fixed sights and a tip-up action operated by pulling down the trigger guard which serves as a lever for opening the gun. The handle is very large and bulky and the barrel lies very low on the frame so as to be close to the line of the shooter's arm. There is a hole in the butt for the attachment of a skeleton stock which can be used with the pistol converted into a short rifle for accurate work up to 150 yards. This pistol is almost universally used for .22 caliber target shooting with the pistol in Great Britain. The photograph shows a gun of this type won by the author as a prize at Bisley in 1931. The gun is very comfortable to hold but seems hard to shoot after using our American pistols because of the rather heavy trigger pull which runs around six pounds on the sample that I have.



Webley and Scott Single shot Target Pistol given as First Prize in the Pistol Match at Bisley, England, in 1931. Won by the author, shooting an 8 inch barrel Harrington & Richardson.

In view of the fact that the sights are not adjustable I was somewhat surprised on first using this pistol to make an actual score of ninety-three on the standard American target at 20 yards with my first ten shots. This score is better than my average with any gun and indicates that this Webley & Scott pistol is accurate and that the sights were properly adjusted at the factory for the average user. The weight of the pistol is 37 ounces.

FOREIGN FREE PISTOLS

It has been mentioned above that under our American shooting rules the length of all target pistols and revolvers is limited to not over ten inches. There is, however, one exception. In Europe shooting is done at fifty meters on a target with a ten ring which is smaller than that on our fifty yard target and the European match rules allow barrels up to 20 inches long and permit hair triggers.

The single shot pistols generally seen at the international matches are, therefore, fitted with set triggers and with barrels anywhere from ten to fourteen inches long depending on the fancy of the user.

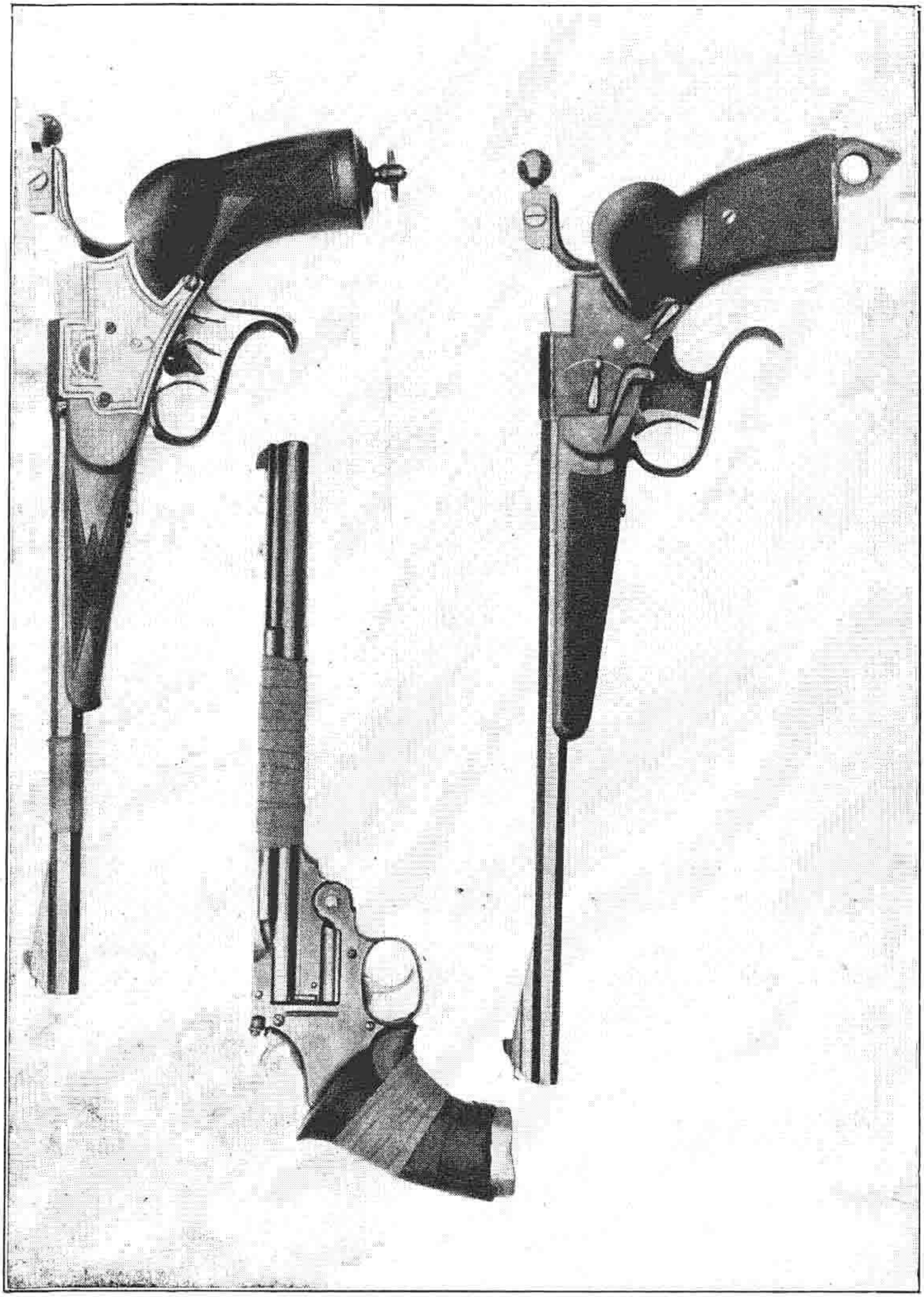
In order to give opportunity to American shooters who favor this type of shooting both the U. S. R. A. and the N. R. A. have special matches at fifty meters under the international rules which allow barrels up to 20 inches long and place no restriction on the trigger pull.

The writer, who has attended several international matches in Europe, has naturally been interested in these free pistols and has procured several of them of different makes for his own use with a view to trying out the advantages of the set trigger and the unlimited sighting radius which is even longer than the length of barrel would indicate because in recent years the practice has arisen of mounting the sights on an extension which curves back over the hand so as to extend the sight radius.

On these pistols the fancy of the European gun makers has been given free rein in the matter of handles. Generally there is a shelf for the thumb on the left hand side and also a ledge or projection at the lower part of the grip on the right, to support the bottom of the hand. Frequently these grips are made full at all points, so that the gun maker can fit them to the hand of his individual customer. When you take hold of one of these guns with the grip properly fitted to your hand, you have only to extend your arm and the pistol very nearly holds itself.

The Buchel Pistols

Among the well known makers of these pistols are Ernst Friederich Büchel of Zella-Mehlis, Germany, who makes the Tell and Luna patterns. The Tell pattern has a handle that slopes back at quite an angle with the barrel, and with this pistol it is necessary to bend the wrist down sharply in order to aim at the target. Some marksmen prefer this shape because they think that the tension placed in the wrist by bending it down adds stiffness to the arm and takes away muscular tremor. Another school of marksmen prefer the grip at such an angle that the wrist can be in a natural position, so that there will be no strain whatever on the arm.



Single-Shot Target Pistols seen at the International Matches, St. Gall, 1925, by the author. Left: Stotzer Perfekt Pistole. Center: Author's S. & W. Single-Shot. Right: Author's Widmer Pistol (Buchel action).

These guns have a falling breech block, which is swung downward and into the frame of the gun by the action of a lever in order to expose the breech of the barrel for loading. The "Tell" pattern has a lever, lying along the back of the stock, which is lifted up to depress the breech block. The later improved model, called the "Luna," has a ring, in the bottom of the grip, which is pushed forward to open the action, thus making it unnecessary for the marksman to change his hold on the gun in order to reload. Both the "Tell" and "Luna" pistols weigh approximately forty ounces with twelve inch barrel.

There is another make of free pistol that is well known, called the Stotzer Perfekt Pistole. This gun operates by pushing down the trigger guard.

It is quite common for different European gunsmiths to buy these actions and fit their own barrels; and for this reason the quality of the free pistols found on the market is variable, as some gunsmiths will use a very high quality and accurate barrel carefully bored for the best American cartridges; whereas others will take a cheap barrel rifled for the .22 short and simply chamber it out to take the long rifle cartridge. For this reason it is wise in purchasing a free pistol of this type to be sure that you get it from a reliable gunsmith who makes his living by catering to marksmen of reputation.

The Stoeger Pistols

A. F. Stoeger, Inc., of 507 Fifth Avenue, New York City, imports foreign arms of all kinds. The "Tell" and "Luna" pistols, above described, can be purchased from them. In addition they always stock a number of foreign made target pistols usually with the tip-up action, sometimes with set triggers and sometimes without. These pistols are reasonable in price and satisfactory in quality. In addition Stoeger handles various foreign types of ammunition which cannot be obtained elsewhere in this country. The real pistol enthusiast will find the Stoeger catalog a valuable addition to his library.

TARGET REVOLVERS

As stated before, it is easier to obtain the very finest possible accuracy from the single shot pistol than from any other type of arm, and for that reason those who specialize in target shooting only, will always be found using single shot pistols. It is more difficult to get the finest accuracy with a revolver than it is with a single shot pistol because in the revolver the cartridge is exploded in a separate chamber in the cylinder and must pass from this chamber into a barrel before it encounters the rifling. In doing this it must move through a certain travel in the cylinder, which is not rifled; and then it must jump a gap into the barrel. In general, the less the travel of the bullet before it hits the rifling, the easier it is to obtain the finest accuracy; and the more perfectly the cylinder is lined up with the barrel the more accurately will the gun shoot. In constructing the revolver it requires the most meticulous care to insure that the chambers in the cylinder are in the same line as the barrel, and that successive chambers line up properly as the cylinder is turned. However, such is the perfection to which the manufacture of the revolver has been brought, that the modern .22 caliber revolver will now shoot with practically the same accuracy as can be obtained with the finest target pistols.

Up until a few years ago all .22 caliber revolvers were made on a very small frame. Fortunately in the last several years a number of the finest full sized target revolvers have been manufactured in .22 caliber so that the user of a large caliber revolver can attain proficiency with his arm by the use of the cheap and highly accurate .22 caliber long rifle cartridge in arms which are exact duplicates both as to size, weight and action of the regular military and target revolvers using expensive, high power cartridges.

The Smith & Wesson .22-.32 Heavy Frame Target Revolver

Back in 1908 Phil B. Bekeart, a gun dealer of San Francisco, persuaded Smith & Wesson to build a .22 caliber target revolver that would be large enough for the average man to shoot with comfort. In order to insure that the firm would not lose money on the deal, Mr. Bekeart guaranteed that he would buy one thousand of the new revolvers. The result was the production of a .22 caliber revolver on the frame of the regular .32 police model. While this gun was very much larger than any other .22 on the market at the time the handle was undesirably small for target use, and in order to overcome this disadvantage a larger size wooden grip was supplied to fit over the small .32 caliber frame.

While this gun was anything but a "heavy frame" model according to present day standards, it was so much larger than anything on the market at that time in the .22 caliber, that it met with an instant and most gratifying popularity. Moreover, the superb workmanship for which Smith & Wesson is justly famous was embodied in this gun in a very high degree, so that it has always been a gun that any revolver enthusiast might be justly proud to own. Today the average revolver shot will no doubt prefer the somewhat larger K-.22, but the .22-.32 will continue to hold its own as a wonderful gun for those who prefer a somewhat lighter weapon. For example, most women shooters will find the .22-.32 preferable to the larger models.

This gun was at first called the Bekeart model, and is still often referred to in that way. It was made a standard model by Smith & Wesson in 1911, with a six inch barrel, a cylinder holding six shots, and a rear sight adjustable for windage and elevation. Its accuracy is such that it has shot groups of 1½ inches in diameter at fifty yards from a machine rest. Weight 23 ounces.

The Colt Police Positive .22 Target Revolver

At about the same time that the Smith & Wesson firm brought out their Bekeart model, Colt produced a .22 caliber target revolver of similar size known as the Police Positive Target. This gun was very much of the same size and weight as the .22-.32, and was also made on the .32 frame. The handle is somewhat larger and longer than that of the corresponding Smith & Wesson gun. In this gun the rear sight is adjustable for windage and the front sight is adjustable for elevation.

The earlier guns of this model were made with a rather slender grip with rubber side pieces; of late years the grip has been made considerably larger and walnut stocks are used. The earlier guns weighed about 23 ounces and the later ones weigh about 26 ounces. The author obtained one of these guns in 1911 when he was stationed in Florida and used .22 caliber shorts in it for reasons of economy, purchasing them by the case. This gun gave superb service and showed conclusively the advantage of using cheap ammunition and doing plenty of shooting with it as a method of training for pistol proficiency.

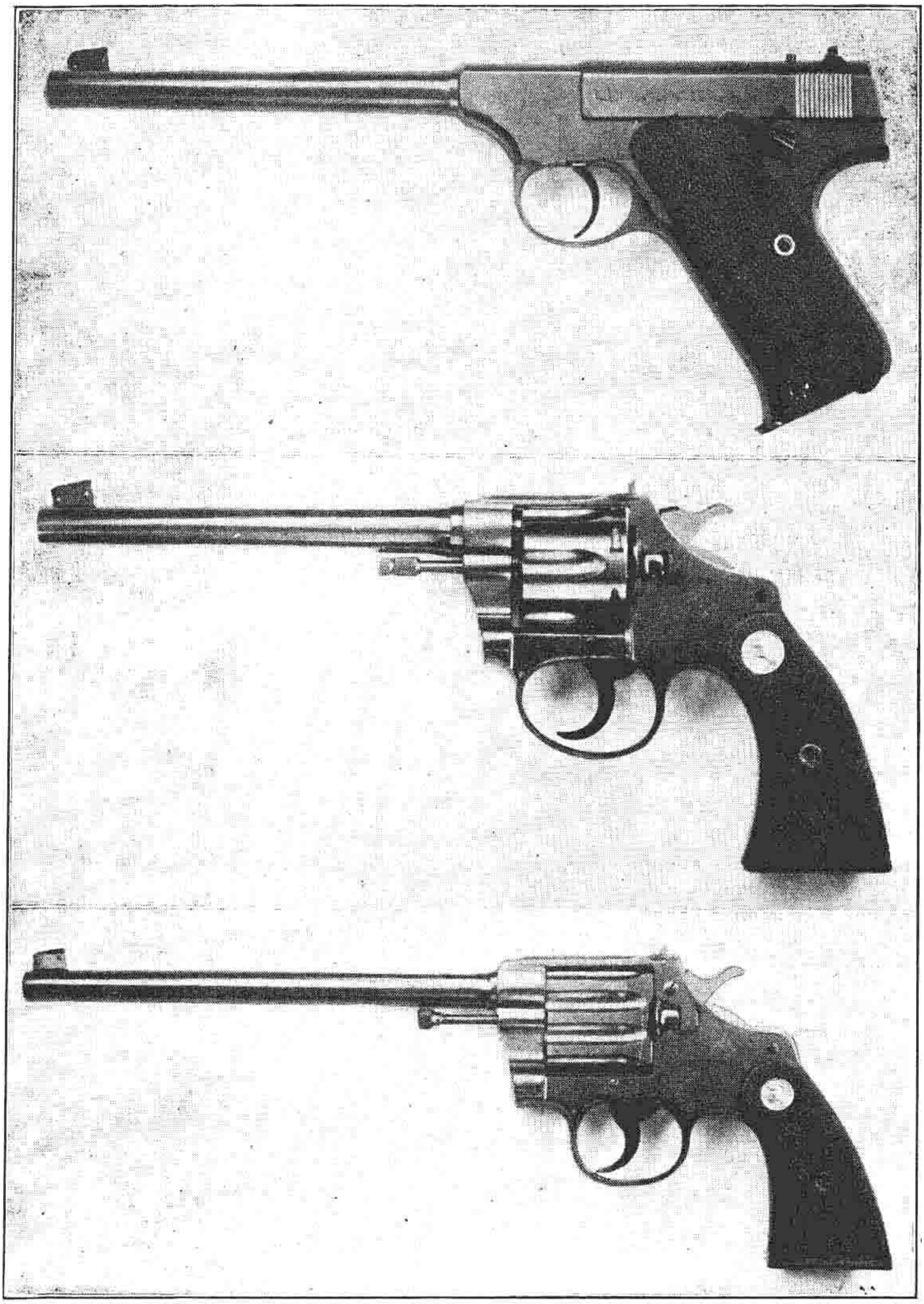
This gun is made in .22 long rifle (using also the .22 short); .22 W. R. F.; and .32 Police Positive calibers. The barrel length is six inches. This is a first class .22 caliber target revolver which is highly recommended to those marksmen who prefer a gun somewhat lighter than the Officer's Model .22.

Smith & Wesson Military and Police

This is a full size Military Style .38 Special caliber revolver made with four, five or six inch barrels. For many years a Smith & Wesson revolver of this general type, chambered for the .38

long Colt cartridge, was one of the standard side arms of the United States Army, sharing this honor with a similar Colt model formerly called the Army Special and now known as the Official Police.

The Military and Police is made either with fixed sights as in the



Three outstanding target hand-guns. Top: The .22 Colt "Woodsman." Center: The .22 Colt Police Positive target revolver. Bottom: The .22 Colt single-shot "Camp Perry" Model; the original gun with 10 inch barrel and curved trigger.

Army guns above mentioned, or with adjustable target sights, in which case it is known as the Military and Police Target. In the fixed sight model it can be had with either the round or the square butt; and incidentally the round butt is preferable for almost every purpose.

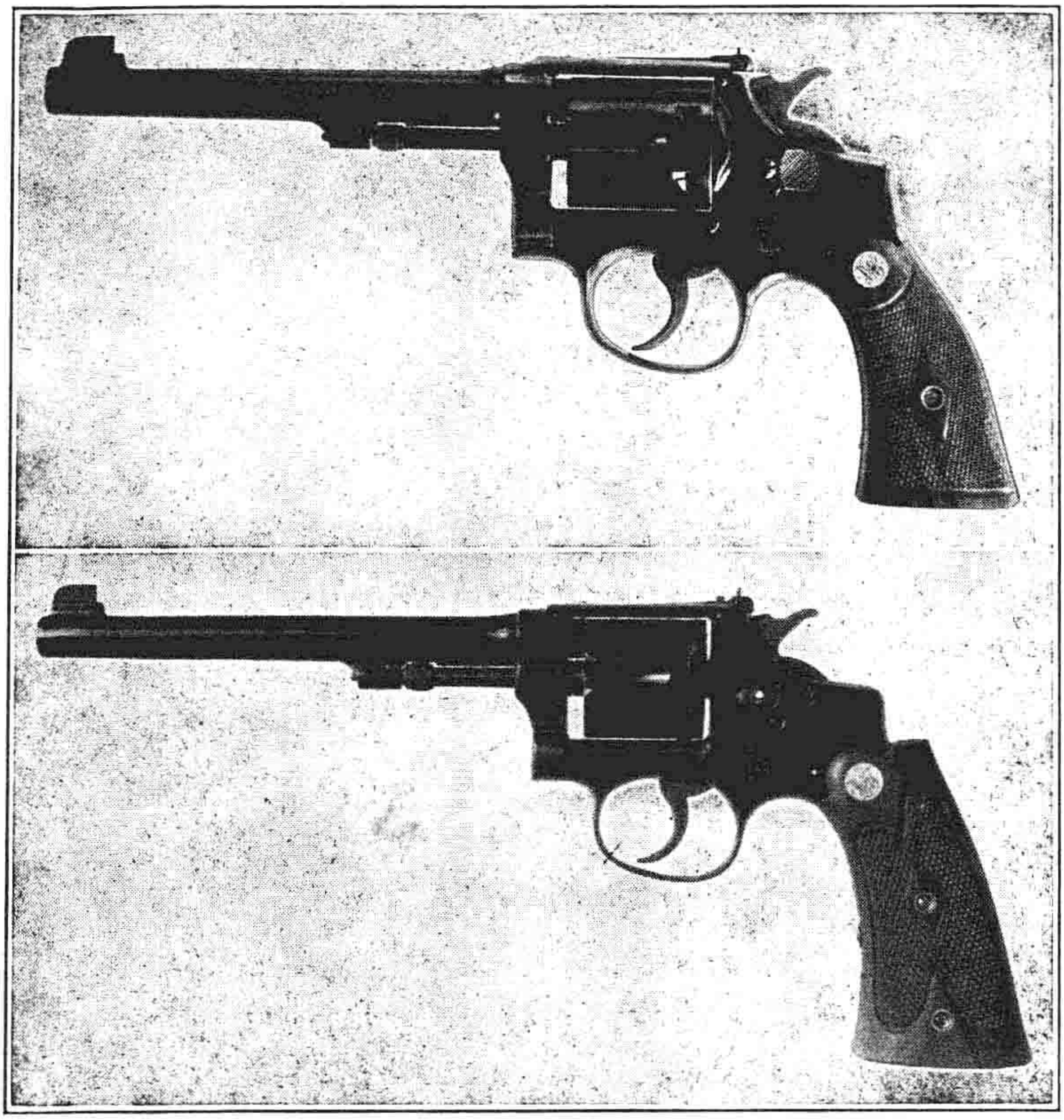
This is a most admirable arm and one that has no superior in its class in the world. It is medium in size and weight, and yet with the powerful .38 special cartridge it is suitable for almost any use. The lockwork is as smooth as velvet and the accuracy is superb. With the round butt and four inch barrel this makes a wonderful self-defense arm well adapted to being carried in the shoulder holster or in the overcoat pocket. Weight of the gun with six inch barrel is 31 ounces. This model can also be had chambered for the .32 Winchester cartridge.

Smith & Wesson K-.22

For this gun, the first "Outdoorsman's" revolver, the pistol enthusiasts of America have to thank the foresight and inventive genius of Major Douglas B. Wesson of the great Smith & Wesson firm. Major Wesson is one of the most progressive arms manufacturers of the present day and is constantly working to produce new guns which will embody the greatest possible advantages for the shooter. In the K-.22 he has produced a masterpiece.

This gun was first designed when Remington brought out their Hi-Speed .22 caliber ammunition in 1930. This very greatly improved .22 caliber cartridge was sold with a caution against using it in pistols or revolvers where the head of the cartridge is unsupported and there might be danger of injury to the shooter from burst heads due to the very high pressure necessary to get the increased velocity. At this time Major Wesson had it in his mind to produce a full size .22 caliber revolver on a .38 frame to act as a companion gun to the .38 Military and Police above described; and at the same time he built this new gun specially for the recently designed high speed ammunition. The heat treated cylinders that Smith & Wesson had been using for sometime had of course more than ample strength for the cartridge; the only weak point was the rim. This point Major Wesson took care of by producing a countersunk cylinder with recesses for the cartridge heads, so that the rims of the cartridges are supported all around, and the danger that the fingers will be cut or burned by escaping gas, or that the adjacent cartridges in the cylinder will be prematurely exploded, is absolutely avoided. Moreover, the rifling in this new gun was especially adapted to obtain the highest accuracy with the new cartridges.

While the accuracy in the early K-.22 was up to the usual Smith & Wesson standards, and therefore was excellent, a further great improvement has been made since that time. This improvement was accomplished by the invention by Major Wesson of a special machine rest for testing the revolver. Previous to the invention of this new machine rest it had been very difficult to make a rest of any kind that would hold the revolver satisfactorily enough for accuracy testing. However, the problem was finally solved, and



Upper: The Smith & Wesson K-.22. An outdoorsman's revolver of the highest grade. It is built on the same frame as the famous Model K-.38, or Military and Police.

Lower: The Smith & Wesson .22-32 Heavy Frame Target Revolver. This gun, often called the Bekeart Model, was the favorite .22 caliber revolver until the advent of the K-.22 and the Officer's Model.

with the new rest all variable factors in testing for accuracy were removed and the factory was put in a position to determine with absolute certainty the effect of any change in design that might be tried out. This new rest embodies certain novel features that have been kept secret by the company, although the author has had the pleasure of seeing this rest and working with it.

Another improvement embodied in this gun is the burnishing of the chambers. The chambers of all Smith & Wesson revolvers, including the K-.22, are reamed rather small and then burnished longitudinally to exact size, giving a perfectly smooth, mirror like surface, and insuring extremely easy extraction as well as freedom from rust.

This gun has a fully adjustable rear sight, with the screws so threaded that one turn of the adjusting screw will change the point of impact one inch for each ten yards of range. The front sight is of the square or "Patridge" shape with a gold bead inlet into the rear surface flush with the face of the sight. This is named the "Call" sight and is the most satisfactory sight for use either indoors as a target sight when the gold bead is not seen, or outdoors in the woods.

It has been stated above that the K-.22 has been made especially for the Hi-Speed ammunition, but naturally it will use the regular or low speed .22 ammunition equally as well.

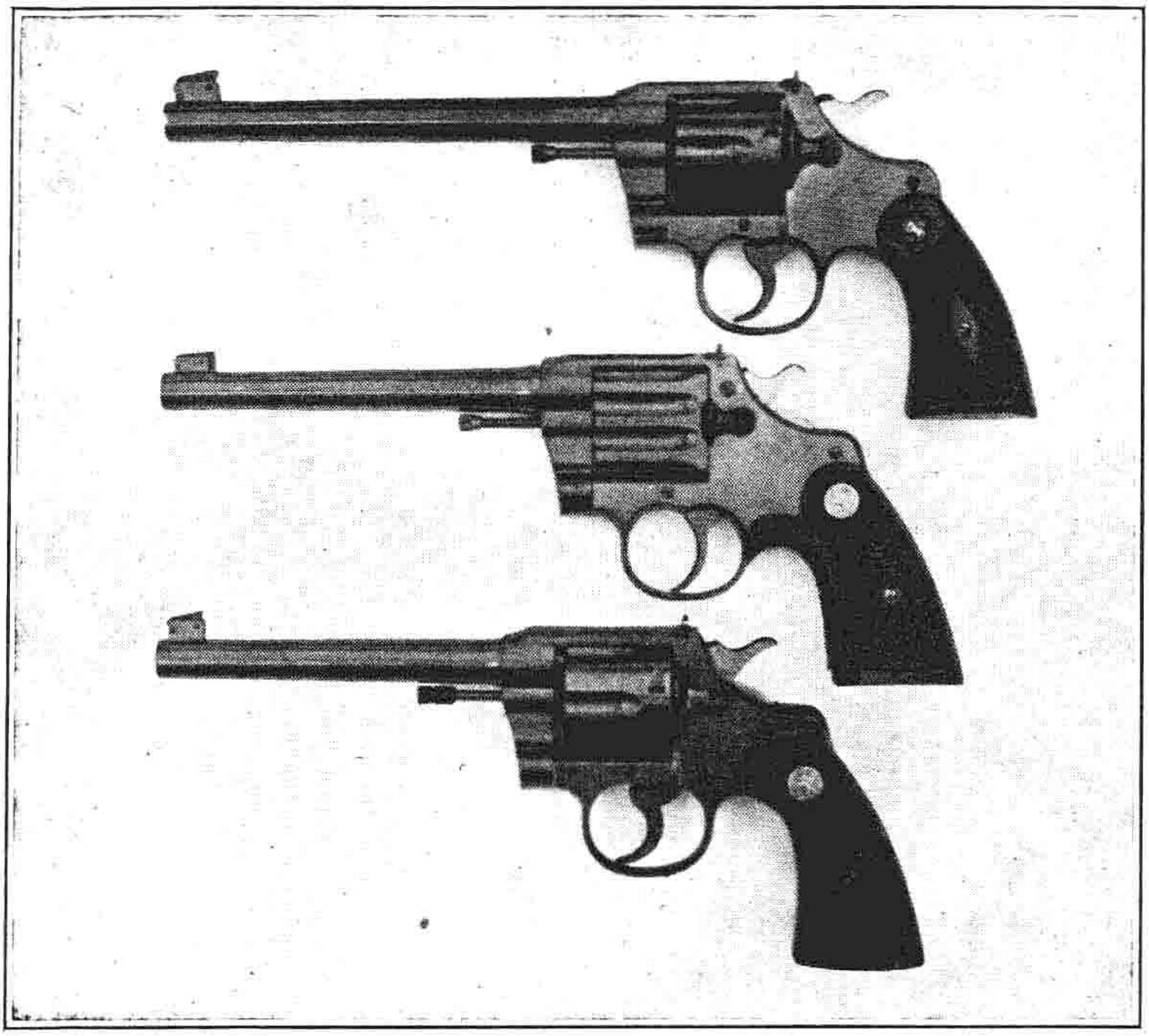
This revolver is made only on the following specifications:
Caliber: .22.
Frame: .38 M. & P. Target.
Length of Barrel: 6 inches only.
Number of Shots: 6.
Sights: Call gold bead front, Patridge square notch rear, adjustable for windage and elevation. Other sights fitted on request.
Distance Between Sights: 7⅛ inches.
Trigger Pull: 3 to 4 pounds.
Finish: Smith & Wesson blue.
Stocks: Checked Circassian walnut with S. & W. monogram.
Straps and Trigger: Grooved to prevent slipping.
Weight: 35 ounces.
Cartridge: Any .22 Long Rifle.
Accuracy at 50 Yards: 1½ inch circle.
Accuracy Life: At least 100,000 rounds.

Colt's Officer's Model and Colt's Official Police

As mentioned above, for many years the standard side arm of the Army was the Colt .38 caliber revolver and a Smith & Wesson

.38 caliber revolver of similar size. These revolvers were chambered for the .38 long Colt cartridge. After the advent of the .38 special cartridge, the Colt gun of this type was called the "Army Special." It was a large size .38 caliber military type revolver with fixed sights and a cylinder holding six shots.

In response to the demand for a similar gun for the special use of target shots the Colt firm brought out a gun like the Army Special except that it had adjustable sights, finely finished lockwork and every refinement that was known or could be suggested for target work. This superb weapon attained an enviable reputation as the Colt's Officer's Model Target Revolver and there is no finer gun made today. It is furnished with a 4½, 6 or 7½ inch barrel in .38 special caliber, and recently, much to the satisfaction of target shots who for years have been demanding a full



Three guns for different purposes all on the same frame. Top, .38 Caliber Colt Officer's Model Target Revolver. Middle, Colt Camp Perry Model Single Shot Target pistol. Bottom, .22 caliber Officer's Model Target Revolver. The Single Shot Pistol is fitted with a Pachmayr Sure Grip Adapter. This is a fine battery of guns for the all-round target shot, as when he is used to one grip he is used to all. Fear the man who sticks to one type of gun.

size .22 caliber revolver on a .38 frame, this gun has been brought out in the .22 long rifle caliber with a six inch barrel only.

The gun formerly known as the Army Special is now called the "Official Police" and is also made in .22 caliber. It is the same as the Officer's model except that it has fixed sights and the lockwork is not as finely finished. Both of these guns as well as all other modern Colt revolvers embody a safety feature known as the "Colt Positive Lock," which is a block of metal resting between the hammer and the frame of the gun, except when the trigger is pulled, and thus positively preventing the cartridge from being exploded by a blow on the hammer or by dropping the gun. In the Officer's model the rear sight is adjusted for windage and the front sight for elevation.

The Official Police is furnished in .32 Winchester (.32-20) and in .38 Special with four, five or six inch barrels and in .22 caliber with six inch barrel only. Weight with six inch barrel 34 ounces for the .38 and 38 ounces for the .22 for both the Official Police and the Officer's model.

The Smith & Wesson ".44 Military" and ".44 Target"

For a military side arm of the largest size and greatest power Smith & Wesson produce a gun known as the ".44 Military" using the highly accurate and very powerful .44 S. & W. Special cartridge and also using in the same gun without change the .44 Russian cartridge. This gun is made with a five or 6½ inch barrel, fixed sights and a cylinder holding six cartridges.

A similar gun with adjustable sights suitable for the finest target work is called the ".44 Target."

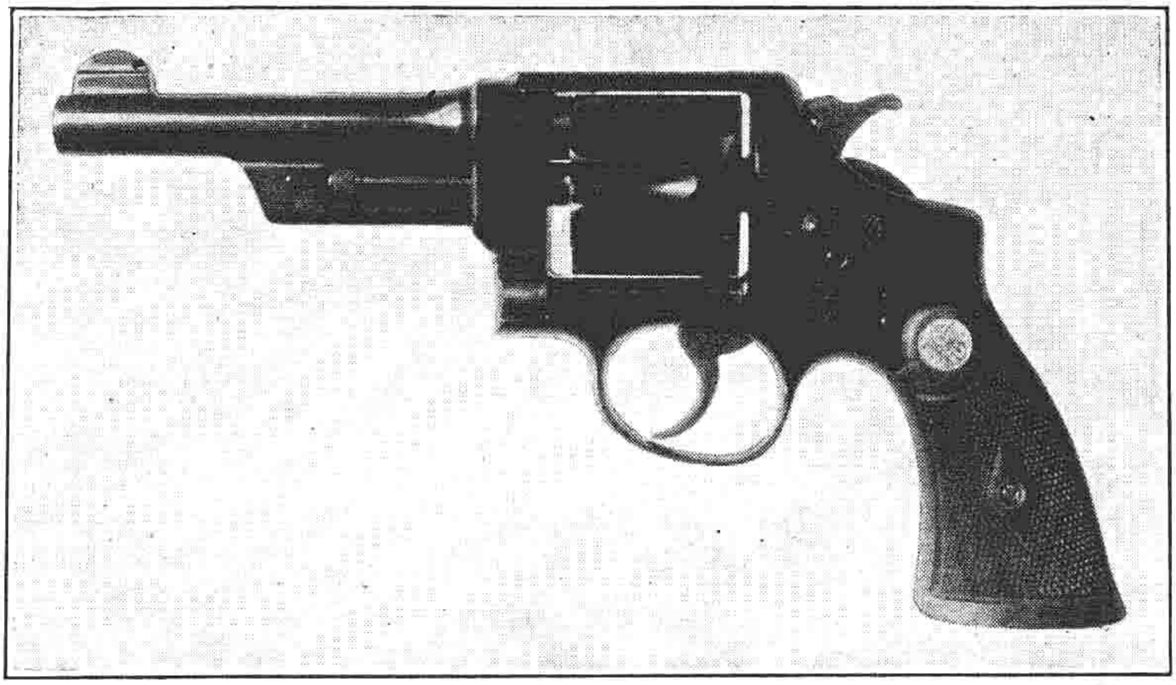
It was the .44 Military rechambered for the automatic pistol cartridge and fitted with a special clip designed by Smith & Wesson that became the "model of 1917" Army revolver, together with the Colt's New Service also chambered for the automatic pistol cartridge.

Weight of both the .44 Military and the .44 Target is 38 ounces.

The Smith & Wesson .38/.44 Outdoorsman's Revolver

This is the .44 Target redesigned to shoot a .38 special cartridge which has been improved to give it 1100 foot-seconds velocity instead of 860 foot-seconds which is standard. The new cartridge, made especially for this .38 caliber revolver on a .44 frame, is called the .38/44. As was the case with the K-.22 this new Outdoorsman's revolver and the improved .38/.44 cartridge were originated by Major Douglas B. Wesson.

It will be appreciated by the experienced revolver shot that increasing the power of the .38 special cartridge by stepping up the velocity to 1100 feet will not only greatly increase the effectiveness of the cartridge but will also result in a very heavy recoil. It is specifically to take care of this heavy recoil that is the reason for using the heavy .44 frame for this .38 cartridge. The weight of this large size revolver, 41¾ ounces, is sufficient to absorb the recoil of the new high velocity cartridge with no more shock than is felt when the ordinary .38 special cartridge is used in the Military and Police revolver.



The Smith & Wesson /.38/44 Heavy Duty Police Revolver. This gun, on the frame of the .44 Military, is chambered for the ultra-powerful .38/44 cartridge, which gives a muzzle energy of 425 foot pounds with 1100 feet per second velocity.

After much experimentation, 6½ inches was decided on as the proper barrel length for this gun to give it the most favorable balance; and it is furnished only in this length barrel. When desired a special patented filler piece can be obtained to take up part of the space behind the trigger guard. In the author's opinion this filler piece is an advantage and improves the use of the gun.

On account of the very high power of the new cartridge used in this gun an additional refinement has been added in the shape of a set screw in the rear sight, just forward of the adjusting screw, which serves to lock the adjustment in place so that it will not become deranged by the shock of shooting.

While this new gun is designed especially for the high power .38/.44 cartridge, the regular .38 special cartridge can be used in it as well, and when this is done it is an exceedingly pleasant shooting gun, as the weight absorbs almost all of the noticeable recoil. At twenty yards no readjustment of sight is required in changing from one cartridge to another but at longer ranges it will be found that decidedly less elevation is needed when using a .38/.44, due to its tremendous velocity.

There is another gun called the .38/.44 S. & W. Heavy Duty revolver, which is similar to the one described above except that it has fixed sights and a 5 inch barrel. This makes a superb heavy duty police gun, as the penetration is very great, so that it is suitable for stopping automobiles or any such duty.

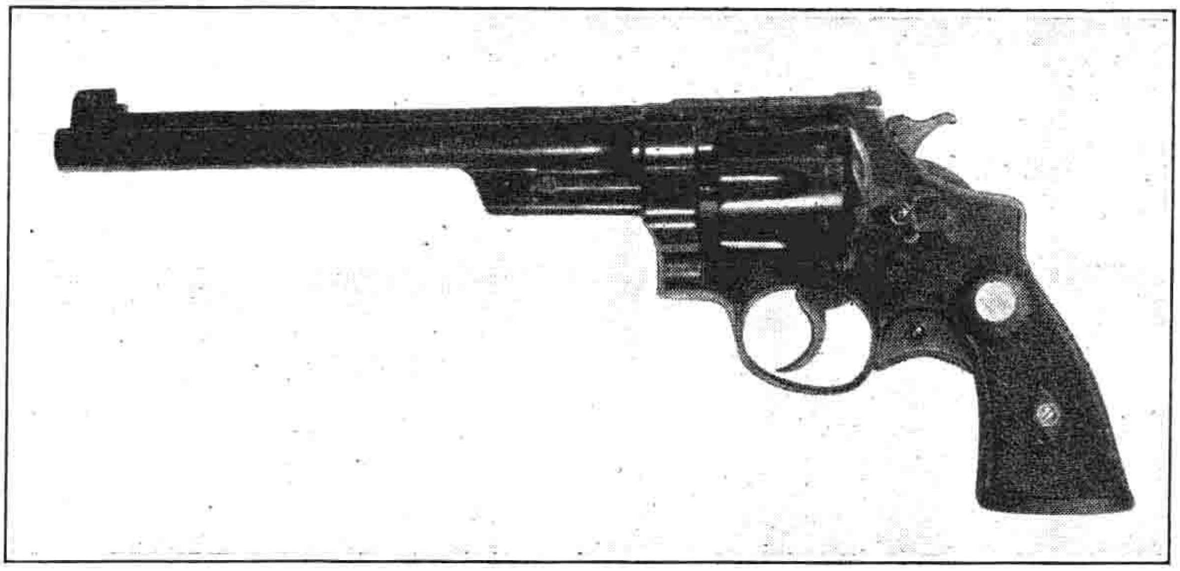
The Smith & Wesson .357 Magnum Revolver

When this book leaves the press the Smith & Wesson .357 Magnum Revolver will be the very newest thing in the firearms world. In fact this book will carry the first announcement of this great new gun to the public.

In June, 1934, Major Douglas B. Wesson visited Annapolis, where I was living at the time and as we sat together one evening discussing firearms problems in general and the .38-44 Revolver and cartridge in particular, our conversation turned to the stopping power of bullets and the very remarkable effectiveness of some high speed loads which Major Wesson had developed using the 160 grain Keith bullet. During the course of this conversation I learned that Major Wesson was planning to take this remarkably effective bullet and build an entirely new cartridge around it. All previous standards or limitations as to pressure or recoil were to be disregarded and the entire object would be to make the most effective possible revolver cartridge. Ultra high velocity was to be obtained at any cost and then when the cartridge was perfected a gun would be built capable of handling it no matter what the pressure or recoil might be. Four months later I was shooting the first one of the new guns to leave the factory; and it came to me under the very suggestive name of the .357 Magnum. And truly a fitting name it is for this great gun—"the doggonedest hand cannon that has ever been produced" Major Wesson calls it.

It is built with the frame of the .44 Target as a basis. This is the same size as the frame of the Smith & Wesson .45 Model 1917 Army Revolver so that with a cylinder and frame of such large dimensions the gun would be amply heavy to take care of any recoil and amply strong to stand any reasonable pressure. But in addition to this large size frame, the gun has still greater size and weight because the barrel is 8¾ inches long and has a rib along the top for the full length from cylinder to muzzle. With this 8¾ inch barrel the gun measures 14¼ inches long overall and weighs just three pounds when fitted with the Smith & Wesson grip adapter which is regular equipment on this model. When the adapter is removed the gun weighs three ounces less.

The top of the rib, and the frame over the cylinder as well, are finely checked to prevent the reflection of light. The usual Smith & Wesson target rear sight, adjustable for both elevation and deflection is fitted to this gun, and the rear sight, like that on the .38-44 Outdoorsman has an additional screw just in front of the elevation screw to lock the sight adjustment after it has been correctly set. The gun of course has the patent safety hammer block which makes it safe to carry a live cartridge under the hammer.



The Smith & Wesson .357 Magnum Revolver. This great gun is an ultra high-velocity weapon built on the frame of the .44 Target. The chambering for the new Smith & Wesson Magnum Cartridge is the same as for the regular .38/44 and .38 Special Cartridges, so that these cartridges also may be used in the same gun. The barrel length is 8 3/4 inches. The gun is a marvelous performer at any range, and has shown wonderful groups at 50 yards, but its real capabilities become apparent when long range shooting (200 to 300 yards) is attempted. At the time this book goes to press this is the newest thing in hand-guns, as the first shipments to the public will go forward in January, 1935.

In spite of the name ".357," the gun is chambered so that it will handle the regular .38-44 and .38 Special as well as the new Smith & Wesson .357 Magnum cartridge. As a matter of fact the bullet diameter of the Magnum cartridge is the same as that of the .38 Special, but in this new cartridge the name has been changed to show the real caliber. Actually the .38 Special cartridge has always been made with a bullet diameter of .359 and barrels bored for the .38 Special cartridge have a land diameter of about .357.

Thus the new gun is correctly named for its caliber which is not the case with the older .38 Special guns. An excellent reason for the new name is to discourage careless individuals from confusing the ultra powerful .357 cartridge with the old style .38. With the new name for both the cartridge and gun there will be less danger of some user attempting to fire this powerful load in a gun which is not specially designed for it with the resultant possibility of accident.

Now a word as to the cartridge itself. It has a shell of the same dimensions as those of the .38 Special except that it is 1/10 of an inch longer. It is loaded with the 160 grain Keith bullet to as high a velocity as this bullet will stand without danger of stripping or of having the base fuzed by the heat. Of course this cartridge is brand new at this time and it is to be expected that some changes will be made in the ballistics as experience is gained; but there is no reason to anticipate any further changes in the gun. In order to handle this cartridge with absolute safety, the extra precaution has been taken of recessing the cylinder so that it completely surrounds the head of the cartridge the same as it does in the K-.22.

I have been fortunate enough to have been able to do quite a bit of shooting with the Magnum and in spite of its great barrel length the gun feels exceptionally well balanced when it is used with the grip adapter, which is regular equipment. This device can of course be removed in a few moments, but without it the gun feels muzzle heavy. There is something in the weight and balance of this gun, and in the way the grip adapter positions the hand, that makes the gun seem to want to lie steady in the hand when the trigger is pulled, without any particular effort on the part of the user to accomplish this steadiness.

I noticed this quiet balance when I first snapped the gun, and when I actually shot it at fifty yards I was amazed at the result, for four of my five shots were in a group 1½ inches in diameter and the other shot was about four inches to one side. Considering the fact that this shooting was done strictly off hand and under very poor weather conditions this group was truly remarkable and is much better than I am ordinarily able to do. Further shooting at 100 and 200 yards fully confirmed the 50 yard result and convinced me that this is a truly great slow fire, long range revolver. Smith & Wesson do not recommend this gun for the ordinary user, as they state that it is intended for men of large build and more than ordinarily powerful physique, but in spite of its great size I did not find it at all difficult to control. It points easily, and the rather heavy weight and long barrel absorb the recoil and jump of either the Magnum cartridge or the .38-44 until it is hardly noticeable at all.

The present plan of the company is to make this gun on special order only and not to carry it regularly in stock. As each gun is ordered specially, any barrel length from 3¾ inches to 8¾ inches will be furnished at the option of the user.

The Colt "New Service" and "New Service Target"

For years the ultra heavy military revolver has been the Colt .45. The current model of this gun is called the "New Service" and is chambered for the .38 Special, .38/40, .44/40, .44 Special, and .455 Eley as well as for the regular .45 Colt. This gun has 4½, 5½ or 7½ inch barrel and weighs 41 ounces with the 5½ inch barrel. It has fixed sights and a Colt positive lock. Chambered for the .45 Colt it was used in the United States Army under the name of Model of 1909 and chambered for the .45 Automatic cartridge it is known as the Model of 1917.

This same gun with the 7½ inch barrel and adjustable target sights and all lockwork hand finished for target use it is known as the "Colt New Service Target" and is an exceptionally fine heavy caliber target revolver. The world's record for the first perfect revolver score recorded under official match conditions at twenty yards was made with this gun. As is usual with the Colt arms the rear sight is adjustable for windage and the front sight for elevation.

The Colt Shooting Master

This is a .38 caliber target revolver of the very highest refinement built on the frame of the Colt New Service described above. It is frankly a specialized target revolver. In the design of this gun everything else was subordinated to producing an instrument that would give the very highest target scores capable of being obtained with a large caliber revolver.

The gun is built on the frame of the New Service Target but it differs somewhat in appearance from that gun as the shape of the handle has been changed so that it looks more like the handle of the famous Bisley Model. The grip is narrower in the fore and aft direction, especially at the bottom, and is thinner. The choice of dimensions seems to have been a happy one for it has sufficient length to fit a large hand and at the same time is thin and narrow enough to be comfortable for a shooter with a small hand.

The barrel is 6 inches long, with a special taper scientifically designed to damp out barrel vibrations and thus secure the highest possible accuracy.

The length and taper of the barrel have been coordinated with the frame in order to secure perfect balance and the result is that while the gun is heavier even than the New Service Target, its balance is such that the additional weight is not noticed. Nevertheless the weight is there and it aids materially in holding steadily under windy conditions and in addition, it gives this gun quite an advantage in rapid fire because the additional weight reduces the recoil of the .38 Special cartridge to a point where it is not disturbing in the least.

The weight of the "Shooting Master" is 44 ounces and that of the standard .38 target revolvers is in the neighborhood of 34 ounces. As the recoil energy with a given bullet weight varies inversely as the square of the weight of the gun, this means that the "Shooting Master" gives only 59% of the recoil felt with the standard .38 target revolvers.

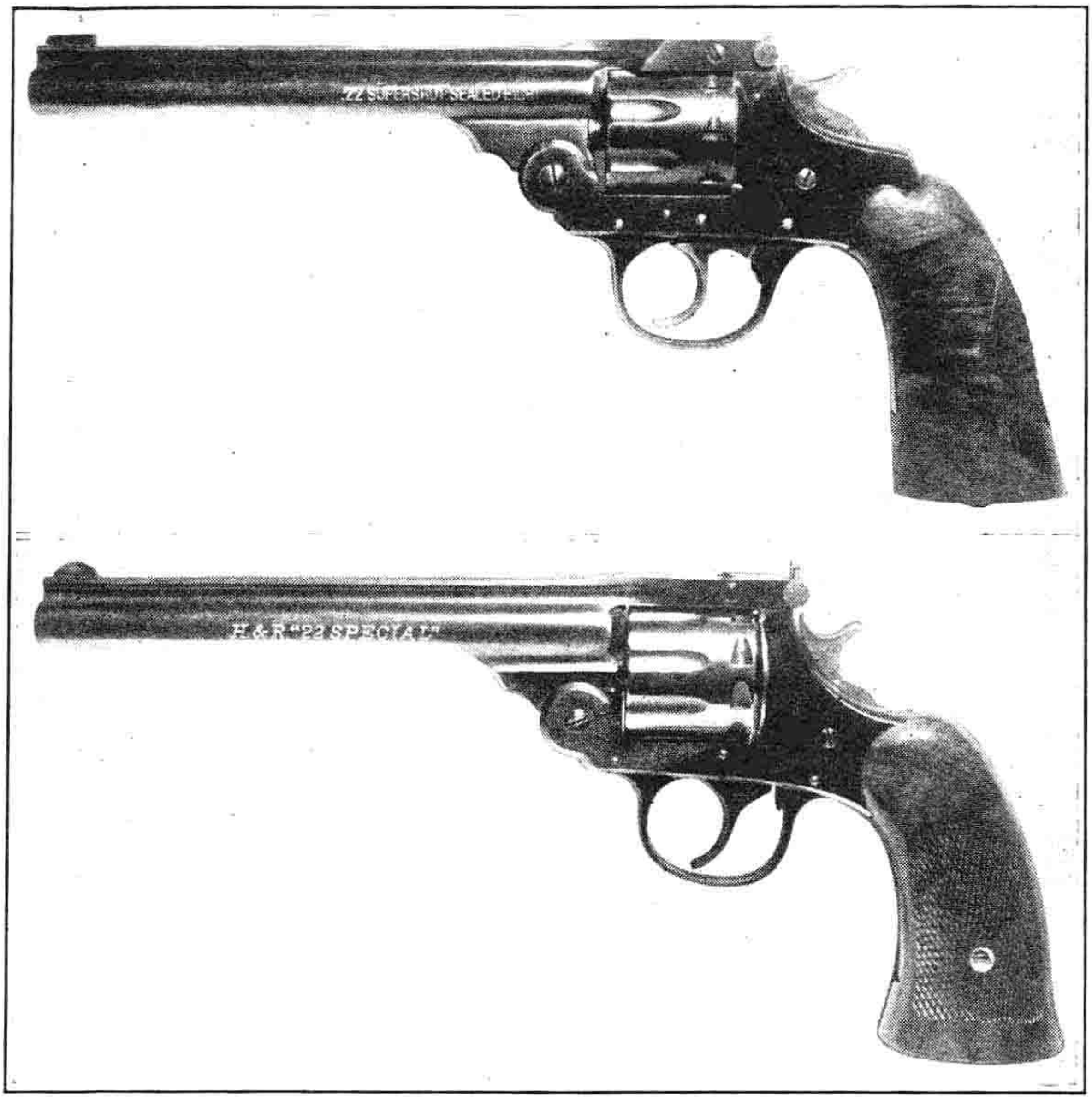
In the .38 caliber this gun is now furnished, at the option of the purchaser, with a special heavy barrel which some marksmen find adds steadiness to the aim, damps out vibration and reduces the jump. The strong, powerful marksman of good physique will find the heavy barrel to be a distinct advantage, while the shot who does not employ sufficient practice to enable him to hold a heavy gun without fatigue will prefer the regular barrel.

The Iver Johnson "Supershot Sealed Eight"

This gun is called by the makers a sport revolver. It has a cylinder chambered for eight cartridges as the name indicates, and moreover, the heads of the cartridges are countersunk into the cylinder so as to prevent the escape of gas from burst heads which is likely to happen in case a defective cartridge is encountered, especially when using the high velocity cartridges.

The cylinder is made of high carbon alloy steel, heat treated to give the greatest possible strength and the factory states that each gun is targeted and tested with proof loads giving 10% greater breech pressure than any .22 caliber long rifle factory loaded cartridge. In the words of the maker, "This model is especially adapted for target practice, vacation sports, and camping, and will prove amazingly effective for game, especially for small animals and harmful pests. The length is 10¾ inches and the weight is 24 ounces."

An examination of this gun shows that it is a handsome, well balanced .22 caliber revolver, with gold finished front sight and adjustable rear sight of Patridge design. It has a six inch barrel with a top rib which is finished with a dull matte finish to prevent reflecting light.



Upper: The Iver Johnson "Supershot Sealed Eight." An eight shot revolver with the cylinder counterbored to allow the use of high-speed .22 caliber cartridges, without danger from burst cartridge rims. A very satisfactory gun for a low price.

Lower: The Harrington & Richardson .22 Special. A suitable revolver to take on camping trips and outings. It is very inexpensive, but is capable of satisfactory accuracy.

The trigger is grooved vertically to prevent slippage of the finger. The walnut grip is amply large for any hand and is checked on the back to prevent slipping.

The earlier models of this gun had a grip with a projection, or lip at the top of the handle, to position the hand, but this lip had the disadvantage that it prevented the user from taking a high grip on the gun. This high grip is the best one for accuracy, and is the favorite with target shots. In 1932 the company adopted a new grip, called the Hi-Hold Grip, which, to my mind, is excellent, and gives just the right position of the hand for accurate shooting. In addition, in 1934 the Company added a very clever and convenient finger rest to the Supershot Sealed Eight. It consists of a spur of metal attached to the front of the frame between the wooden grips, so as to bridge over the space behind the trigger guard. This finger rest is adjustable as to position, as the screw holding it to the stock works in a slot, so that by loosening the screw the spur can be moved up or down to a limited amount.

This gun embodies the famous Iver Johnson "hammer the hammer" safety. This device comprises a lever operated by the trigger. When the trigger is pulled this lever rises and the hammer strikes it and transmits the blow through this hammer to the firing pin. However, when the trigger is not pulled, this lever is down out of the way and the hammer cannot strike the firing pin. Therefore, this gun is perfectly safe to carry with all chambers loaded and the hammer down as dropping the gun or striking the hammer cannot cause a discharge unless the trigger is pulled all the way back. In the same way, if the hammer slips out from under the thumb while cocking the gun, a discharge cannot occur. This is a valuable feature and has no doubt saved many lives.

An examination of the interior parts of the gun shows that the hammer, trigger and sear are well finished and are case hardened. The mainspring is a coil spring instead of the flat spring used in some other makes, and in fact, all the springs in the gun are coiled piano wire springs guaranteed by the makers not to lose their strength or break. The cylinder is fitted with an independent cylinder stop which registers and locks the cylinder in line with the barrel each time the hammer is cocked. When the hammer is down this cylinder stop prevents the cylinder from rotating which sometimes happens with makes which have a rachet cylinder stop instead of the positive stop.

The action is made on the tip-up system, which is excellent for a .22 caliber revolver, as it allows the easy removal of the cylinder for cleaning, and when the action is open and the cylinder removed, the breech of the barrel is readily accessible. The cylinder is held in place by the latch that serves also to open the gun for loading. To remove cylinder, simply lift up the latch and tip up the barrel as for loading, then, with the action open, lift up the latch and draw the cylinder off its axis.

The balance and hang of this gun are very comfortable, and it fits the hand well. Both the accuracy and durability are satisfactory. My average score with the "Supershot" on the Standard American Target at twenty yards runs between 87 and 90, and I have made scores as high as 93 on occasion. The trigger pull is rather hard, and naturally the lockwork does not have the smoothness of that on the high priced and beautifully finished Colt and Smith & Wesson guns, but it must be remembered that they cost about two and a half times as much. For the price this "Supershot" revolver is excellent value.

The Harrington and Richardson .22 Special

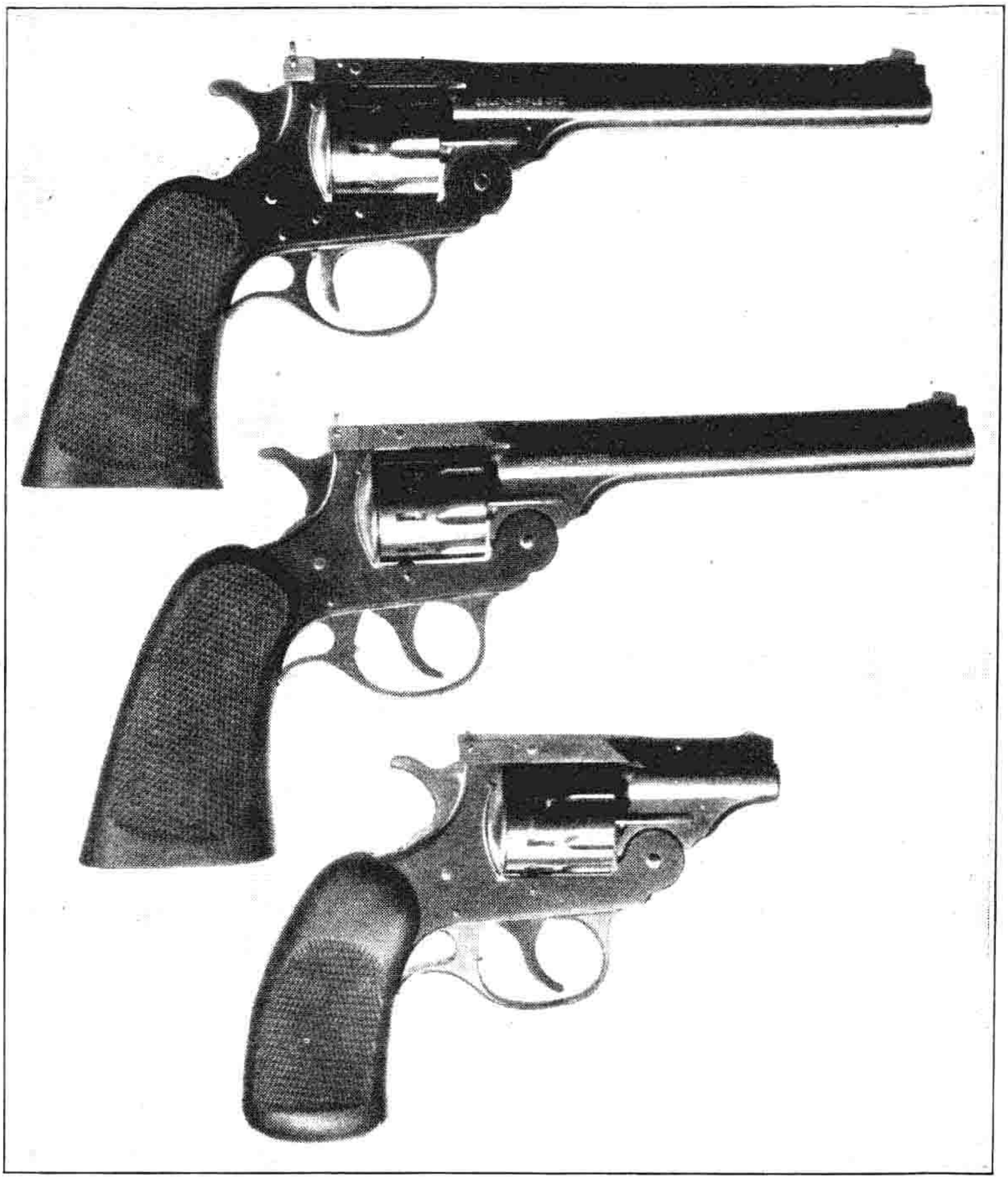
This gun is very similar to the Iver Johnson Supershot in size, shape, price, action, and performance. However, the H. & R. has a cylinder capacity of 9 shots, instead of eight and it does not have the "hammer the hammer" safety as this is a patented Iver Johnson feature. The gun does have a half-cock notch which to a certain extent takes the place of the "hammer the hammer" feature, as when the gun is placed on the half-cock, the hammer cannot fall and the gun will not go off if dropped. Moreover, if the hammer slips from under the thumb while cocking, a discharge cannot take place as the hammer will catch on the half-cock.

This H. & R. gun does not have the head of each cartridge sunk into the cylinder, but instead it has a recess to hold the heads of all the cartridges and a guard ring or raised portion outside the cartridge head to stop any gas from coming out and injuring the firer's hand should a burst head occur. Weight of the gun, 25 ounces.

Harrington & Richardson "Sportsman" .22 Cal. Revolver

This arm, which can be had in either Single Action or Double Action lockwork, is a highly accurate target revolver which has been placed on the market very recently by the Harrington & Richardson firm, in an endeavor to give the revolver shooter a gun with the same features that have made the H. & R. Single Shot pistol so eminently successful.

The Single action model is almost a duplicate of the U. S. R. A. Model Single Shot Target Pistol as regards shape, size, weight, and balance. Like the Single Shot, it has a frame that will take the five interchangeable grips that can be had for the pistol. It also has the same type of trigger guard, with a spur of metal extending back, to fill up the space behind the trigger guard, and give a rest for the middle finger. The lockwork is as nearly the same as it can be, with the addition of the necessary parts for turning and locking the cylinder.



The Harrington & Richardson "Sportsman" revolver in three forms. Top, the Single Action Sportsman Revolver. Middle, the Double Action Sportsman Revolver. Bottom, the New Defender, which is nothing more or less than the double action Sportsman with the barrel cut off to 2 inches, and fitted with a modified No. 2 stock.

In designing this gun, Walter Roper had in mind the well deserved popularity of the old Single Action guns of frontier days, and he made the handle as nearly a duplicate of the old frontier grip as he could. It is the Harrington & Richardson No. 4, or

Frontier grip, and while any of the other four standard H. & R. grips will fit the frame of the revolver, none of them are as good as this one. It seems to give just the right feel and balance. The cylinder holds nine shots, and embodies the H. & R. Safety Cylinder, with a steel ring surrounding the heads of the cartridges, to eliminate danger in the case the head of a high speed cartridge should burst.

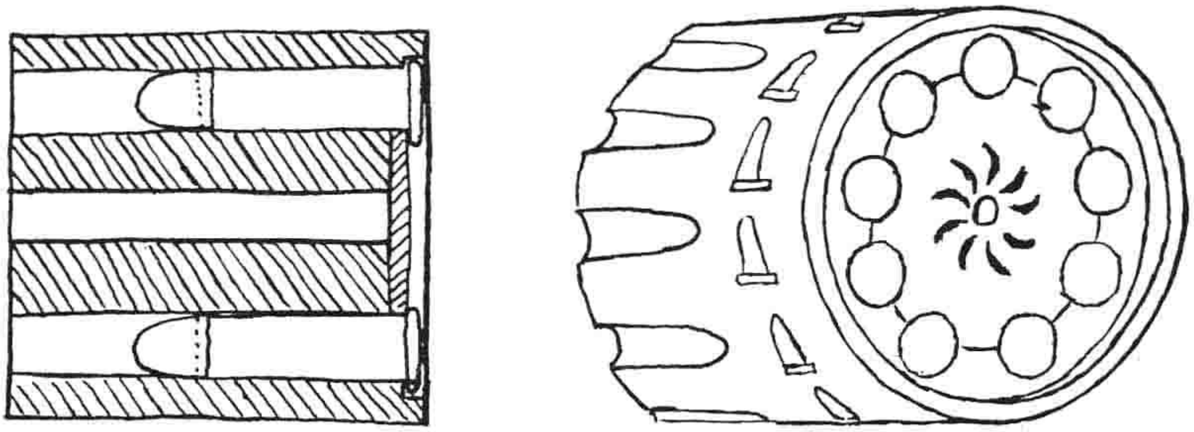
The rear sight is adjustable for windage, by means of two screws, one on each side, having 80 threads per inch. The front sight is adjustable for elevation by means of a screw in the end of the barrel, above the bore. Turning this screw in raises the sight, and one turn of the screw raises the sight blade ten one thousandths of an inch. The front sight screw is flattened on opposite sides, so that it moves by half turns, and as the front sight is pivoted, and held in its lowest position by a spring, it always rests on one of these flat sides, and thus acts to hold the adjusting screw from moving accidentally.

The distance between sights on both the single action and the double action models is 7¼ inches, and consequently a half turn of the elevation and windage screws will move the shot group the amounts indicated in the table below for the various ranges:

Range	*Amount shot group moves for each ½ turn front sight elevation screw*	*Amount shot group moves for each ½ turn rear sight windage screws*
25 feet	.21 inch	.26 inch
10 yards	.25 "	.31 "
15 yards	.37 "	.46 "
20 yards	.50 "	.62 "
25 yards	.62 "	.77 "
50 yards	1.25 "	1.55 "

These guns are of the hinged frame type, in which the barrel and cylinder tip up to eject and load. When the action is open, the cylinder can be instantly removed for cleaning by pressing a spring catch on the right side of the barrel. Removing the cylinder greatly facilitates cleaning the barrel, also, as it leaves the breech fully exposed.

A notable improvement in the lockwork of these guns is the double point trigger, which eliminates trouble with trigger pulls, such as having the pull change spontaneously with wear. In this new mechanism, there are two separate trigger points and hammer notches, one for the full cock position, in which a fine pull is required for actual shooting, and another for the half cock and rebound notch, which does the heavy work of keeping the mechanism safe from accidental discharge in case of dropping the arm, or a blow on the hammer. Previously, when the trigger pull has been made very light, there has been trouble with the half-cock notch striking on the point of the trigger and breaking the point, or changing the trigger pull. In this new mechanism there is no chance of the half-cock notch on the hammer ever striking the full-cock point of the trigger, for the hammer cannot fall far enough to bring the points together. Moreover, the half-cock point on the trigger and its notch on the hammer are placed further from the center than the full-cock point and its notch, so that when the trigger is pulled in firing, the half-cock point and its notch are widely separated, and there is no possibility of their striking. Mr. Harrington is justly proud of this device, and he tells me that since the change, the trouble that was formerly encountered with trigger pulls has entirely vanished. A study of the diagram shown on page 28 will make this clear.



The new Harrington & Richardson Safety Cylinder, in which the cartridge heads are located in a recess in the end of the cylinder, and are surrounded by a raised portion, or guard ring, to prevent damage in case of burst cartridge heads, which may occur in using high velocity .22 caliber cartridges.

Since the introduction of the Sportsman Single Action Revolver it has not only become prominent as a winner in the revolver matches, but has also made scores which are new high records, Dr. I. R. Calkins having made a new record of 280 x 300 in the "Slow, Time, and Rapid" match on Feb. 2, 1933, and Mr. G. W. Bassett having made a new high record score of 470 x 500 in Match K in the Indoor Championship Matches of 1933.

Both the Single Action and the Double Action Sportsman Revolvers are regularly furnished with 6 inch barrels, but the Double Action Model can also be had with a two inch barrel under the name of the New Defender; or with a three inch barrel for pocket use. Weight, with 6 inch barrel, 30 ounces.

The New Webley Mark IV .22 Target Revolver

This British revolver, of excellent design and workmanship, has a 5 inch or 6 inch barrel, as desired; is 10⅛ inches long over all, and weighs 30 ounces. It has a hinged frame and tip-up action, with the rugged stirrup lock for holding the action shut, which is a feature of the Webley line. Capacity of the cylinder, 6 shots.

In common with the other revolvers made by Messrs. Webley & Scott, this gun has a handle of excellent design and proportion. A notable feature is the very generous amount of space between the grip and the trigger guard. In this particular, as well as in the general slope and contour of the grip, this gun is ahead of its American contemporaries. As it comes from the factory this gun has a particularly light, clean trigger pull, weighing between two and three pounds, and shooting it is a pleasure. It has my full recommendation.

.22 CALIBER AUTOMATIC TARGET PISTOLS

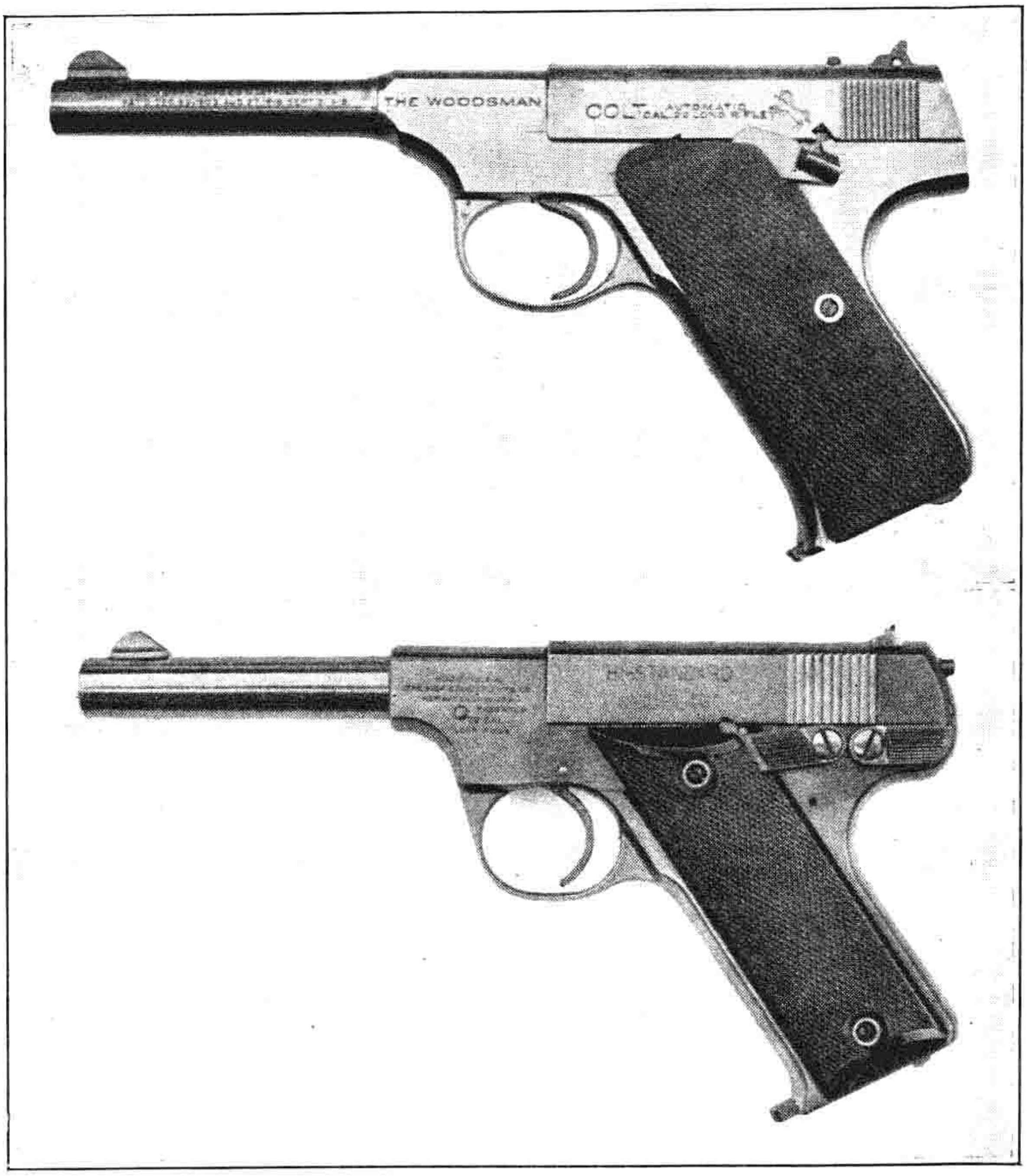
There are a number of excellent and highly accurate .22 caliber automatic target pistols now on the market. They are invaluable as training weapons for the Military shot who must use the Automatic Pistol as his standard arm, or for the target shot who wishes to prepare himself to shoot the Service Automatic in the National Matches.

In these pistols the cartridges are loaded into a detachable magazine in the handle, and the first one is inserted into the chamber by drawing back the slide and then letting it go forward. This leaves the arm cocked. A pull on the trigger fires the shot, whereupon the arm automatically throws out the old cartridge and inserts a new one, remaining cocked ready to be fired again by another pull of the trigger. The trigger must be released and pulled again for each shot, as continued discharge will not result from one pull of the trigger. A thumb safety is provided to lock the gun against the danger of accidental discharge.

The Colt "Woodsman"

This pistol, designed by the late John M. Browning, of machine gun fame, is one of the best balanced hand arms ever manufactured, and has shown itself capable of the finest target accuracy. It is a first class arm to carry on hunting or camping trips. The fit and balance of the gun make it a fascinating arm to use and the fact that its shots can be followed up so fast quickly teaches rapid fire.

It is a most necessary hand gun for a well equipped pistol shooter's armory, and one that should be in the hands of every enthusiast who follows the game extensively, but the words of warning which follow should be taken to heart and an attitude of great care should be cultivated in its handling and use.



Top: Colt "Woodsman" .22 Caliber Automatic Pistol with 4½ inch barrel. Note the improved shape of the fixed front sight. The rear sight is adjustable for deflection.

Bottom: The Hi-Standard .22 caliber automatic pistol, Model B. This gun is shown in the 4½ inch barrel style, but is also made with a 6¾ inch barrel.

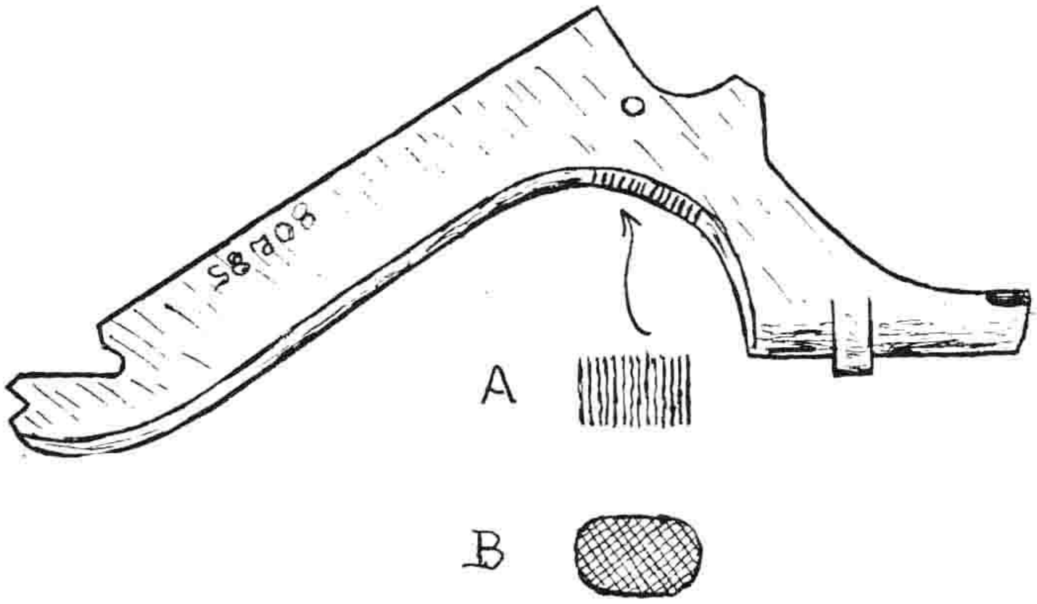
This is not the gun for a beginner. Its automatic and hammerless action are confusing to the tyro, and he cannot tell from a casual look whether or not the gun is loaded. The large number of shots carried in the magazine prevents one from unconsciously counting the shots as they are fired and there is a tendency to lower the gun and snap it on what is supposed to be an empty chamber, when in reality there may be two or three shots left in the magazine.

The strictest of care should be used with this arm to prevent accidents, because after the first shot, it is always loaded and cocked and it only requires a slight pressure on the trigger to let off an additional shot. The fact it is of only .22 caliber also tends to encourage careless handling of this gun by persons who are not well versed in the use of firearms, as there are many ignorant people who consider a .22 to be more or less of a plaything, while as a matter of fact it is about as fatal as any cartridge and more so than many of them.

This is a gun that is best carried in the holster when it is not being held in the hand for actual firing. In fact, a proper holster is essential to this gun. It is a beautifully designed weapon and has a fatal attraction to on-lookers, and as they usually know nothing about its action or function there is grave danger of an accident if they are allowed to handle it. In the holster this is prevented. Moreover, this is no gun to carry about in the hand while loaded or to slip in and out of the pocket, for its shape is such that about the only way that it can be carried in the pocket is butt first and muzzle up; and as there is always the chance for the safety to work off, such a method of carrying the gun is highly undesirable. I have gotten into the habit of carrying my .22 automatic with the chamber empty at all times, as it takes only a second to slip back the breech block and have it ready to fire. This is also recommended even when the gun is carried in the holster, and on the firing line or in the company of others the gun should always be carried with the breech block locked back and the action left open.

The angle of the stock on this gun is such that when the gun is grasped and the arm extended, the barrel naturally points in a horizontal direction, which is the ideal condition. The distance from the back of the grip to the trigger is such that the trigger comes just at the first joint of the index finger of the average size hand, and thus gives the most favorable leverage for pulling the trigger. I have always found the Woodsman a remarkably easy gun with which to shoot good groups and I believe that these two features have a great deal to do with this inherent tendency to accurate shooting which seems to be built into this gun.

The gun is made to handle the ordinary .22 caliber long rifle cartridge, and has a magazine holding ten shots. The early models of this gun were not intended to handle the high speed .22 caliber cartridges, and after these new cartridges came on the market the company made a number of tests and found that when the gun was used with the high speed ammunition there was a tendency for the mainspring housing, which takes the impact of stopping the rearward motion of the breech block, to bend under the repeated heavy shocks. To overcome this difficulty a new heat treated main spring housing was produced, and the present Woodsman pistols will handle the high speed ammunition with no difficulty. To tell whether or not the housing is the new heat treated type, look at the checking on the curved part under the back of the breech. The old checking is diagonal, while the new style housings are checked straight across in a rectangular pattern. See sketch. This change was made at gun No. 83,790, and to make any pistol with a lower serial number safe for use with the high speed ammunition, it should be fitted with one of the new heat treated mainspring housings, which can be obtained from the Company at a small cost.



Mainspring Housing on the Colt Woodsman Pistol, showing how to tell whether or not the housing is specially heat treated for the use of high speed cartridges. Housings scored straight across as indicated at "A" are of the new type for use with high speed ammunition, while those with oval spot of knurling as shown in "B" are of the old type.

The original Woodsman pistol has a 6½ inch barrel with the rear sight adjustable for windage and the front sight adjustable for elevation, and the sights 9 inches apart. Weight 29 ounces.

In the Spring of 1934 the Colt Company brought out a new

Sport Model Woodsman Pistol with a 4½ inch barrel, with the rear sight adjustable for windage and the front sight fixed, and of a special shape that will not catch in the pocket. The balance of this short barrel Woodsman Pistol is superb, and it is one of the finest shooting guns that it has ever been my pleasure to own. As far as I have been able to tell from an extended trial it shoots equally as well as the longer model, and it has the great advantage of fitting nicely in the pocket, which the other model will not do, as was stated above. The Sport Model Woodsman is one more embodiment of the recently growing tendency toward shorter barrels. This new gun is one of my favorite pistols, and no real pistol enthusiast should be without it. Weight 27 ounces.

Troubles and malfunctions with the Colt Woodsman pistol are very rare but when they do occur they are usually due to a worn or damaged magazine and usually the use of a new magazine will remedy the trouble.

The Woodsman is a gun that is very easy to clean because the breech block can be taken off very readily leaving the rear end of the barrel exposed so that the gun can be cleaned from the breech.

The "Hi-Standard" .22 Cal. Automatic

In outside appearance, balance, feel, etc., this gun very closely resembles the Colt Woodsman. The Hi-Standard pistol is, however, somewhat heavier, and differs from the Colt in several features of the construction, and particularly in the method of removing the breech block for cleaning.

Like the Woodsman, this pistol is made in two models, one with a 6¾ inch barrel and the other with a 4½ inch barrel. Both front and rear sights on both models are fixed. Rifling is right handed, with six grooves. The magazine holds ten shots, and so closely resembles the magazine of the Woodsman that magazines from one make will fit into the other. The barrel is somewhat heavier than that of the Colt, and this makes the gun weigh slightly more. With the long barrel the gun weighs 35 ounces, and with the short barrel it weighs 32 ounces.

On the left side of the gun there is a thumb safety which locks the slide and firing mechanism when it is pushed up, and makes the gun ready to fire when pressed down. Just back of the safety there is another serrated thumb piece which looks like another safety; this is the latch for removing the breech-block. Projecting from the rear end of the breech-block is a knurled stud, which is the end of the recoil spring guide. To remove the breech-block, press in this knurled stud, and at the same time, press down the corrugated latch on the left side. Holding the latch in the down position, draw the breech block to the rear. This leaves the breech of the barrel fully exposed for cleaning from the breech. To replace the breech block, hold down the latch as before, and slide the breech block on as far as it will go, which is about an inch. At this point the front of the breech block will strike against the top of the hammer, which in the cocked position lies almost concealed in the frame. Press down the hammer slightly, and slide the breech block all the way forward. Press in the knurled stud on the rear of the breech block, which will allow the latch to snap up into place. This take-down is extremely quick and convenient. The breech-block can be removed almost instantly, and can be replaced in a fraction of a second.

Obviously, the remarks as to danger, care in handling, etc., given under the description of the Woodsman apply with equal force to the Hi-Standard .22 Automatic, which is a weapon of the same general character.

The Colt Ace

The adoption of the Colt. .45 Automatic by the U. S. Government in 1911 immediately made this pistol of paramount interest to military target shots because the Government's adoption of the automatic meant that this gun would of necessity have to be used in all official military matches, such as the National Individual Match. The natural result was that the great body of military pistol shots who had previously been using the revolver started in to practice with the automatic pistol.

It was soon found that there was a need for a method of obtaining proficiency with the Government .45 that did not involve shooting the very expensive and powerful cartridge which was adapted to this arm. Of course a certain amount of skill in slow fire can be obtained by dry shooting; that is, by snapping the gun carefully at a target with no cartridge in the chamber. This will teach the user to hold the gun steadily and squeeze without deranging the aim, but it does not give him any chance to practice rapid fire. With a revolver rapid fire can be practiced without cartridges by cocking and snapping the gun against time in the same manner as it would have to be done in actual firing, but with the automatic, where the gun cocks itself, this is not practicable, or at least if it is done it does not give the kind of practice that is necessary. One of the common methods adopted among military pistol shots in an attempt to overcome this difficulty, is to tie a string to the hammer of the pistol and then holding the end of the string in the left hand, jerk the hammer back after each time it is snapped. This gives valuable practice but it is still quite different from being able to fire the gun rapidly against a time limit.

The need for a .22-45: These considerations soon led to the wish by users of the .45 Automatic that they could have a cheap way of actually firing the gun without using a cartridge worth from two to four cents each time the trigger is pulled.

This wish obviously pointed to the desirability of a gun similar to the .45 automatic that would fire with .22 caliber cartridges and it was not long after the adoption of the .45 that attempts were made to design such a gun.

An additional need for this sub-caliber arm for the .45 was found in the fact that it is much easier to train a novice in shooting a gun if the recoil, noise and other disturbances accompanying the shooting are reduced to a minimum. The .45 Colt Automatic Pistol, Government Model, is about the most powerful side arm in existence and when the trigger is pulled there is a noise and recoil that is rather startling to one who is not very well used to firearms anyway. As Al Woodworth, ballistic engineer at Springfield, used to say, when a novice with a .45 automatic pistol is trying to learn to shoot he frequently lets the noise and recoil disturb his aim to such an extent that he "shuts both eyes and takes both feet off the ground each time he pulls the trigger."

In other words, with a novice in the pistol shooting game the noise and recoil of a very heavy caliber gun frequently masks the errors of the shooter to such an extent that he cannot recognize the causes of any wild shots he may get. Even if he flinches violently the recoil will cover up this flinching and he will never know it. On the other hand, if you give him exactly the same kind of gun, which will function and fire in exactly the same manner, but which makes a very mild report and gives very little recoil, he will learn to shoot it without being afraid of the noise and the jump of the gun and, consequently, he is far less likely to acquire the bad habit of flinching than he would be if he tried at first to use the full-powered gun. Moreover, he will be able to recognize his faults in shooting and correct them. Then, too, the low price of the ammunition will enable unlimited shooting which will greatly increase his proficiency. The amount of shooting that can be done is further increased by the fact that the .22 is comparatively so low powered that it can be shot in many places where it would be impossible to shoot the .45.

It has been found by experience that when a man once acquires proficiency in aiming, holding and squeezing in actual firing with one caliber of cartridge, his proficiency will be retained when he changes to another caliber. If a man learns to shoot well with a .22 revolver he can usually shoot just about equally as well with a larger caliber.

All these considerations finally led the Government to undertake the development of a sub-caliber weapon for the .45 automatic as long as fifteen years ago. The .22 adapter to go on the .45 frame was constructed at Springfield Armory to shoot the .22 caliber shorts. This worked fairly well and soon after it was made the author, who at that time was in charge of the experimental department at Springfield, had occasion to show the gun to Mr. John Browning, the inventor of the .45 Automatic Pistol, who expressed himself as very much surprised that we had been able to get the gun to work with the shorts.

After playing with these models for several years and sending them out for test, it was decided that it was preferable to change over to the long rifle cartridge, as the .22 short, which had formerly been used for gallery practice by the Army, was being abandoned for that use and it was recognized that the use of the .22 long rifle would give a very much greater certainty of action in the .22-45.

Accordingly, a new .22 was constructed at Springfield on exactly the same pattern, but this time it was made for the long rifle cartridge. Twenty-five of these guns were made, and a number of them were sent out for service test. The model seemed to work fairly well in the factory, but in the service there was always difficulty in feeding from the magazines. The .45 automatic cartridge is a rimless cartridge made especially to feed out of the automatic pistol magazine, whereas the .22 long rifle cartridge has a rim, and it is very difficult to make it work successfully in a magazine that will fit into the handle of the .45 automatic pistol.

During the several years of trial and occasional redesigns of this .22-45 by the Government, the Colt's Patent Fire Arms Mfg. Company, of Hartford, Connecticut, had been an interested observer of the work. From time to time these designs were discussed with the officials of the Colt Company and they gave helpful suggestions. Finally the Colt Company decided to take a hand in this development themselves and they got out a design which differed radically from the one the Government had, though it accomplished the same object.

In the Government .22-45 the slide of the pistol was a solid forging with a hole bored in it to form the barrel and with a recess milled out in the back to take a sliding breech block. This adapter mounted on the .45 receiver made a .22 caliber automatic very much the same size and shape as the .45 and with the same handle, but differing considerably in appearance and also differing in action, in that the slide did not move back with each shot, the only moving part being the small breech block and the spring rod attached to it.

When the Colt Company took up this problem they attacked it in an entirely different way. They made the gun very much more like the automatic pistol in appearance and action. The Colt .22-45 was constructed with the same kind of slide, barrel, recoil spring, and other parts as are used in the .45 model, except that the moving parts were made lighter in order to operate with the comparatively low powered .22 long rifle cartridge.

This Colt adapter was a great improvement over the one made by Springfield and after numerous trials of this device by the Government, ten samples were ordered in 1927 and sent out to the various Army boards for test. As a result of these tests, many changes were found necessary and numerous recommendations were made. After these changes were made by Colt, the devices were again tested by the Army and further changes were found desirable. As a result of the various designs and redesigns made by Colt and of the extended test made by the Army, the .22-45 was finally perfected and when it reached the point where it was apparent that all the difficulties had been overcome, the Colt Company decided to place the gun on the market, and the result is the Ace Target Pistol.

From the above it will be seen that this new Colt gun is not an untried experiment but is the result of years of careful, expensive and painstaking development in which the engineering organization of the Colt Company has had the benefit of a large amount of actual shooting under service conditions in Government trials.

Details of the Ace: On examination the Ace will be found to be an automatic pistol almost exactly resembling the Government .45 or the Super .38 in outside appearance, weight and balance. On disassembling the gun numerous changes in construction will be found in the slide and parts attached to it and the barrel, and in the magazine; the receiver and the parts contained in it are the same as those used on the .45 Automatic. If you disassemble an Ace and a .45 Automatic at the same time, you will note just one difference in the receiver, and that is that in the Ace the ejector is not assembled to the receiver, as it is carried on the barrel. In the Ace receiver one of the little cross holes for pinning the ejector in place is omitted. This is the only change that I can find between the .45 receiver and the Ace receiver. The slide is the same in outside appearance as that of the .45 but it is cut away inside as much as possible in order to make it light enough to recoil under the action of the .22 cartridge. The locking lugs in the slide which hold the barrel and receiver locked together are omitted as they are not necessary in the .22 caliber gun.

The firing pin in the Ace has been specially constructed in two pieces instead of being in one piece as it is in the .45. This is made necessary in order to prevent the firing pin from striking the back end of the barrel when snapping the gun empty. Much of the accuracy of a .22 is dependent on the way in which the rim of the cartridge is struck, and after exhaustive experiments a certain form of wedge shape was found by the Colt Company to be best adapted to give accurate ignition and this form is used on the Ace firing pin. In order to insure that the wedge shaped point strikes the cartridge correctly a small lug is formed on the bottom of the firing pin to prevent it from rotating in its seat.

A most important improvement which is found in this gun and not found on its companions, the .45 Government Model and the .38 Super, is the provision of adjustable target sights of entirely new design.

On any pistol or revolver which is to be used for target practice of any kind or for general "outdoor use," adjustable target sights are almost a necessity. Without adjustable sights the usefulness of a gun for this purpose is severely limited. The variations in individual hold and eyesight are such that it is never possible to be sure that a gun which shoots center for one user will do the same for another. In target shooting with pistols and revolvers it is impossible to make the best scores unless your gun does shoot so that you can take the same definite point of aim each time. On a target you should be able to aim exactly at six o'clock and the gun whose sights are too high or too low so that the user must aim an indefinite amount above or below the six o'clock point, will always spread the group in elevation; and if the sights are off in deflection so that the user cannot aim exactly under the center of the bull's-eye, the chances are that the group will be ruined. When a revolver or pistol has fixed sights it is a matter of great difficulty to adjust the gun so that it will shoot properly with any one user for any one range and under one set of conditions; and when once it is so adjusted it will be incorrect for another user and for another range or set of conditions for the same user.

Only recently I was called on to shoot in a match without any previous notice and the only gun I had at hand was a .38 Special revolver with fixed sights that I had not shot for several years. As soon as I started in the match I found that the gun was shooting slightly low and to the left so that I had to correct the aim and hold off the bull's-eye. I found this to be handicap in the match and it undoubtedly resulted in quite a few points off my score even though I was using my own gun and one that I was fairly well used to.

There is no substitute for adjustable sights. The adjustable sight on the Ace is of an entirely new design which was produced by the Colt Company especially for this model. It has a lateral adjustment which is obtained by means of a cross screw and there is a clamping screw to hold the lateral adjustment after it is made very much the same as is used on the Woodsman, the Officer's Model and other Colt target guns at the present time.

Vertical adjustment on the Ace is not made on the front sight, however, as is the case on other Colt target guns. Instead, the central and rear part of the rear sight is dovetailed on the main part and slides up and down. The vertical movement is given by means of a screw in the top of the sight body and there is an index for reference to show just what adjustment is being used. There is no clamping screw on the elevation adjustment. Instead the elevation screw is split and spring-tempered and it has a snug spring fit in the hole so that the sight will retain its elevation adjustment at any point at which the elevation screw is set. As a safety precaution the elevating slide and elevating screw are so arranged that they cannot be removed entirely from the rear sight and there is no danger of losing them.

The rear sight has a movement of 1/10-inch in the vertical direction which is amply sufficient for any adjustment that may be required, with some to spare. The front sight is of the round form found on the .45 Automatic but is considerably higher in order to match the rear sight whose elevation adjustment brings it higher over the line of the slide than a fixed sight would be.

The front sight is 1/10-inch wide and when viewed through the rear sight notch it gives the effect of a square or Patridge type sight which is ideal for target shooting.

An examination of the inside works of the Ace Target Pistol reveals a surprising amount of painstaking work that the average user never sees. The sear, hammer, disconnector, sear spring, trigger, mainspring housing and grip safety are all hand-finished, giving the action of the Ace Pistol a velvety smoothness which cannot help appealing highly to the lovers of fine firearms and to those who admire fine workmanship. After the nose of the sear is made the exact thickness for the required trigger pull, the front and back of the sear and the slot for the disconnector are polished, and at assembly the corner and top of the sear nose are very carefully honed to give additional smoothness to the pull. The full-cock notch of the hammer is made dead smooth and just the proper depth for the required trigger pull, after which the circular section of the sides, as well as the lower outline including the half-cock notch are hand-polished and the hole for the hammer pin is burnished. At assembly the full-cock notch is honed to give an extremely smooth surface across which the nose of the sear swings. Even the sear spring is hand-polished all over. The inside surface of the grip safety on which the right leg of the sear spring operates is also hand-polished giving additional smoothness to the operation. As a result of the special care taken with these guns, the smoothness of the action is such that the trigger can be squeezed without the slightest tendency of the front sights to jerk or deviate from the line of aim.

One of the greatest problems in this gun was the design of the magazine. As mentioned before, the .22 caliber long rifle cartridge was never designed to be fed from a magazine which had to be fitted into the handle of the .45 Automatic Pistol, and magazine difficulties were one of the stumbling blocks that the Government encountered on its early designs of this nature. It would take up too much space here to tell of all the different expedients that were found necessary in order to get perfectly satisfactory, reliable, smooth operating feeding with the .22 caliber cartridges in the Ace, but just among other things it may be mentioned that the filler used in the back of the magazine is built on a scientifically constructed curve that guides the cartridges to the proper feeding angle in the magazine, and the under part of the breech block in the slide is also cut away at a certain slope which helps guide the cartridges up.

A most difficult problem was successfully accomplished when a way was found to make the follower on this magazine operate the slide stop on the pistol, a thing that was not done on the Government model .22 or the early Colt model .22's that the Government tested. The magazine has a pull-down to hold the follower for ease in loading and the top part of the magazine, including the magazine lip and the ears at the top which guide the cartridge in feeding, is made of sheet steel which is specially heat treated to withstand almost any conceivable rough use to which the magazine may be subjected. The capacity of the magazine is ten shots.

Accuracy: In attempting to obtain the very finest accuracy for this gun, the Colt Company made numerous experiments and finally developed what they term the "super precisioned barrel." There are six lands and grooves, with the rifling twice the width of the lands, left hand, one turn in fourteen inches.

It is absolutely certain that this barrel is highly accurate from a machine rest, but the question that the target shooter is most interested in is how accurate is the gun, including the barrel assembly, sights, grip, trigger, etc.; in other words, "What results can I get by shooting it?"

The fact that this gun has a 4¾ inch barrel and a 6¼ inch sight radius adds interest to the speculation regarding the practical results as to accuracy. There are many novices in the shooting game who think, the longer the barrel, the more accurate the gun. The barrel in itself is not so important in accuracy as many people think, for as soon as the bullet gets started in a given direction it will continue to go in that same direction until something disturbs its line of flight. It does not take a long barrel to start a bullet toward the target. A 4¾ in. barrel is plenty long enough to get a bullet started in the same direction and once the bullet starts in one direction it will keep right on going in that direction until something pushes it to one side or another.

A matter of much more importance than the barrel length is the sight radius. For a good many years the maximum sight radius used on American target pistols has been ten inches, but it has frequently been questioned that the long sight radius is always best. There are many shots who, much to their surprise, find that when they shoot with a short barrel gun, with six or eight inch barrel, they seem to make better scores than with the 10-inch barrel under certain conditions.

At first this may seem to be a puzzler, but on further consideration of this subject it was found that the further apart the sights are the harder it is to see both the front and rear sights clearly. Also, the further apart the sights are, the more apparent motion there is in the sights due to the failure of the user to hold perfectly. Shortening the sight radius not only clears up the sights to the vision, but it also makes the wabble seem less and therefore it makes the holding seem easier whether it is or not, and the result is that sometimes better scores are made with a short barrel and sight radius than with a longer barrel and sight radius under the same conditions.

As mentioned above, the barrel on the Ace Pistol is 4¾ inches long, whereas the barrel on the .45 Automatic is five inches long, and several correspondents have written to me to ask why the difference in barrel length. As explained to me by the Colt people, this is due to the fact that in order to get this gun to accommodate every kind of the many different makes and varieties of .22 long rifle cartridges on the market, it was necessary to have a certain minimum weight for the slide in order to insure certainty of functioning. After hollowing the slide out as much as possible it was found that it was desirable to make it still lighter and this was done by cutting off one-fourth of an inch at the front end.

One of the very frequent questions that I have received on the Ace is as to whether or not the slide and barrel can be purchased separately and placed on a .45 or Super .38 receiver.

The answer is that under present conditions this cannot be done. When the Colt Company first started to get out this gun the original idea was to get a .22 adapter, consisting of barrel, slide and magazine, to be placed on the frame of the .45. It was found, however, that in order to make this gun work with the comparatively low-powered and very variable .22 caliber ammunition, it was necessary to have the fitting done with extreme care. When the Colt .45 was first manufactured it was made by the Colt Company and by Springfield Armory, but with a slight difference in the dimensions of the guns made at the two places. Then when the World War came on a number of other factories were tooled up to make the Colt .45 and many of these ran into great difficulty in maintaining the very close dimensions that had been required on this job in the past and there was constant pressure brought to bear on the War Department to loosen up on the tolerances. The result is that there are many thousands of war-time Colt automatics now on the market whose dimensions are considerably beyond the limits required by the Colt Company. An attempt to fit the slide and barrel of the Colt Ace on one of these guns would undoubtedly result in frequent malfunctions. Moreover, in many of these guns there is a variation in the position of the magazine latch and if the magazine is not held snugly up to the proper place trouble will occur.

For all these reasons the Company foresaw an endless amount of trouble for themselves if they put on the market a .22 adapter, backed by their name and guarantee, that was likely to be used under all of these different conditions. In other words, they felt they did not want to risk their hard earned reputation of many years by a proposition that would almost certainly give trouble, and for that reason feel that they cannot guarantee performance with the Ace unless the receiver and slide are assembled and fitted together at the factory so that all of the very critical points can be taken care of correctly.

The weight of the Ace is 36 ounces which is just three ounces less than that of the .45 Automatic. The capacity of the magazine is ten shots.

A very important feature about the new pistol is that it is designed for the Remington Palma Hi-Speed and the Super-X as well as the ordinary .22 caliber long rifle cartridges.

From the description that has been given above of the tremendous amount of work and expense that both the Government and later the Colt Company put into the production of a satisfactory .22 on the frame of the .45 automatic, it will be seen that the problem was a very difficult one to solve; and although the Ace is a very satisfactory gun, it does not always function perfectly with every make and kind of .22 caliber cartridges. The principal reason for this is the fact that the gun had to be made of the same size and shape as the .45 and for this reason the work of operating the mechanism is just about all that can be accomplished with the .22 caliber long rifle cartridge. Part of the work accomplished by the recoil of the cartridge is cocking the hammer against the resistance of the main spring; and in order to insure greater certainty of operation it was necessary to use a weaker mainspring than that in the .45, so that the hammer would not be so hard to cock and, therefore, would not retard the mechanism so much. This rather weak mainspring means that if the primer of the .22 is not up to standard trouble is sometimes encountered with hangfires or misfires. Moreover, in spite of the weakened mainspring and the easing up of the action in every way possible, it sometimes happens that some makes of .22 caliber cartridges may not have quite power enough to operate the slide with certainty and occasionally the slide will fail to stay open when the last shot has been fired. Occasionally also failures to feed may occur from the same cause. The remedy, when conditions of this kind occur, is to try a different make of ammunition.

In spite of these occasional functioning difficulties the Ace is extremely valuable as an understudy or sub-caliber gun for the large size automatic and is a weapon that no serious user of the .45 automatic or .38 super-automatic can afford to be without. Moreover, to the user of such a gun the purchase of an Ace pistol is an economy as the saving in ammunition will pay for the gun in a few months if any reasonable amount of practice is indulged in.

CHAPTER 3

MILITARY REVOLVERS AND AUTOMATIC PISTOLS

MILITARY revolvers and automatic pistols are large caliber guns of .38 or larger bore, with fixed sights. While they are not as finely finished as are special target arms, they are capable of very satisfactory accuracy, and it is guns of this kind that are always used in the national pistol matches at Camp Perry, and in other military shooting events.

The Colt Single Action Army Revolver

This old gun, which was used in the Army from about 1876 until the time of the Spanish-American War, has been manufactured and sold for well over half a century and is still made and sold in large quantities. Because of its simple construction and its very comfortable grip and because of the great reputation it attained in the early frontier days it is still a favorite and no doubt will retain its popularity for years to come. The gun has a very simple mechanism, aptly described by the saying, "Almost as complicated as a monkey wrench."

To a casual inspection the gun as a whole seems bulky and rugged, and it is true that some of the parts such as the hammer and mainspring are extraordinarily heavy for the work they have to do, but the outside appearance of this gun gives a very false impression, for several of the parts inside are entirely inadequate in size and strength, and I know of no hand gun which breaks down easier or oftener.

The most common break is the cylinder stop spring. Next comes the pawl spring and after that the pawl itself and the mainspring breaks at times. The quarter and half cock notches seldom last long with this model, although their absence may be a benefit rather than otherwise. On continued firing the cylinder pin moves forward on many of these guns and will sometimes drop from place before this motion is detected.

Strange to say, notwithstanding its liability to breakage, it is possible to fire this gun irrespective of what part is broken and this feature is one point that endeared it to the old westerner and frontiersman. If the full cock notch on the hammer is broken off, or if the trigger nose is broken, it is only necessary to hold back the hammer with the thumb, slipping it off when aim is taken. If the pawl or cylinder lock is broken, it is possible to rotate the cylinder into place by hand.

Another reason for the long-continued popularity of this revolver in the West is due to its being safe for use on horesback. The average horse does not take kindly to the report of any firearm and even a mount which has learned to stand firing will sometimes start violently at a report and if he starts cutting up, you are lucky indeed not to let off more than one shot if you are using an automatic, and there is some danger of this even with a double-action revolver.

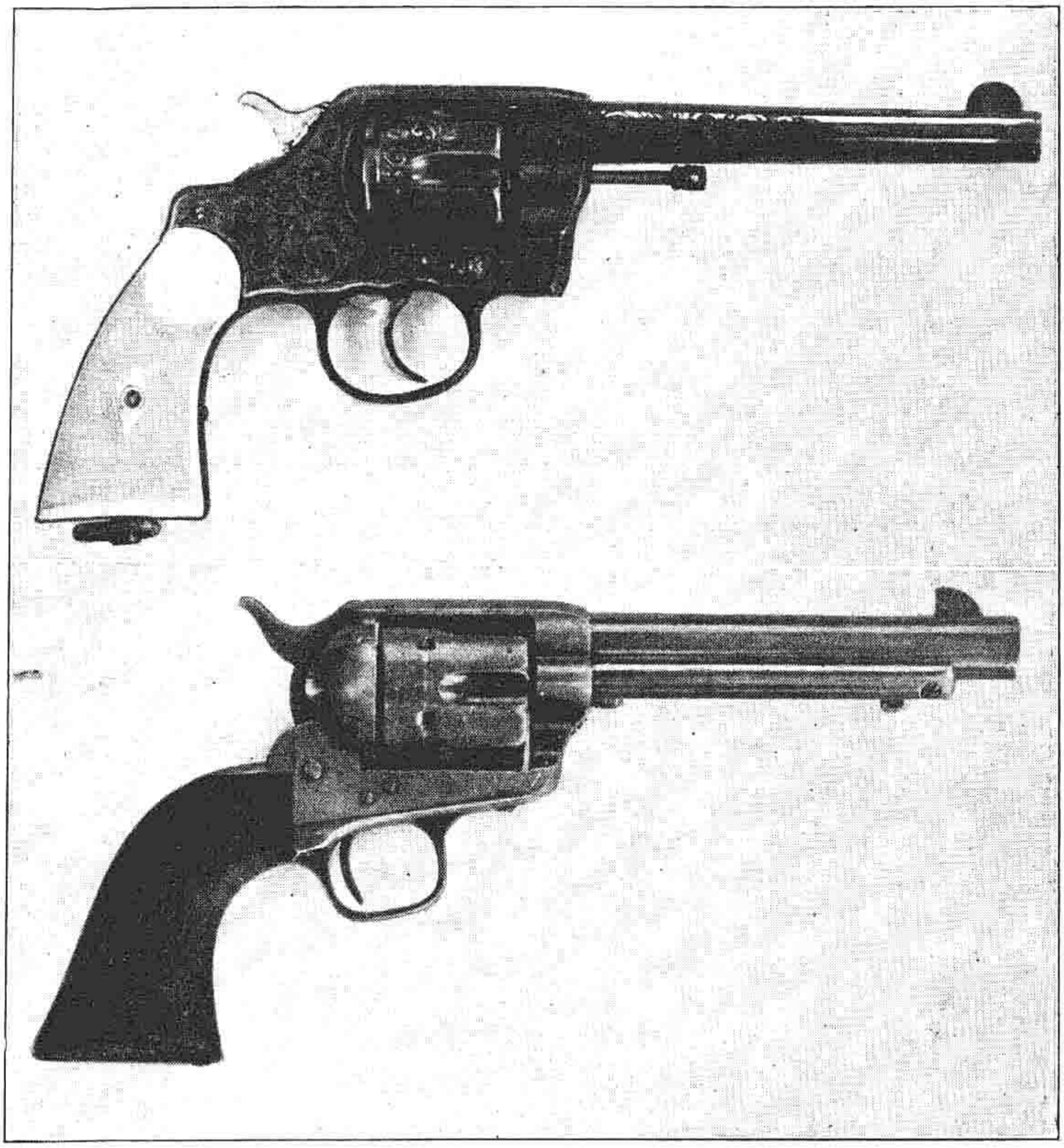
Another reason for its great popularity, is the fact than any old kind of ammunition will work, owing to the extremely heavy hammer and mainspring.

A number of years ago, out on the Rio Grande, I saw one of these guns fished up out of an irrigation ditch and though it had apparently been in the water some time, it went off when the hammer was cocked and the trigger was pulled, which speaks well not only for the gun, but for the ammunition which was in it.

This model is not designed for superaccurate shooting. I do not believe there is anyone who could do first-class match shooting with the single action, and moreover, I believe that anyone who can do fair shooting with this gun, could do better work with an automatic or double action. The long hammer travel, heavy blow, and height of bore above the hand all tend to mediocre shooting and I consider this to be one of the hardest guns to shoot, even fairly well. It has one outstanding feature though, this being the grip, which is without question the best fitting, most comfortable and natural grip on any revolver sold today.

This is the type of gun in which the hammer can be "fanned" by tying back or removing the trigger. "Fanning" is accomplished by holding the gun in the right hand and sweeping the left hand back over the spur of the hammer so as to push the hammer back to the limit of its motion and then release it. As the hammer is swept back by the left hand the cylinder rotates, and as the hand lets go of the hammer it falls and discharges the gun. One shot from the hip can be gotten off very quickly in this way and with ample accuracy for the purposes of a barroom fight or a shooting scrape over a game of cards which figured so often in the stories we hear of the old western frontier days, when this type of shooting was supposed to be in vogue.

This is the only type of revolver now made in which this can be done, as the modern double action guns depend on the motion of the trigger to operate the mechanism which turns the cylinder, and if the trigger is held or tied back the cylinder will not rotate when the hammer is cocked. Recently the late John Newman of Seattle, Washington, and Elmer Keith of Weiser, Idaho, have given prominence to what is known as "slip shooting" with the .45 single action Army. The gun is converted into a "slip ham-



Two obsolete Army revolvers from the author's collection. Upper: An engraved and ivory stocked .38 Colt Double Action. Lower: A Single Action Army .45 with 5½ inch barrel.

mer" revolver by altering the hammer, taking off the hammer spur entirely and substituting for it a short peg projecting to the rear and lower down on the hammer than the conventional hammer spur. The trigger is preferably removed altogether and sometimes the trigger guard itself is also removed. A gun like this can be fired rapidly and accurately by simply drawing the hammer back with the right thumb and then, when it is ready to fire, allowing the handle of the "slip hammer" to escape from under the thumb. The speed with which this can be accomplished is shown by the fact that "Burro Puncher" John Newman has been known to throw a tin can into the air and put four shots into it with his "slip hammer" Colt before it hit the ground. However, the "slip gun" is not as fast as the modern double action. Mr. Ed. McGivern, the well known exhibition shooter of Lewistown, Montana, has done a great deal of experimenting on this point and finds the double action gun much faster. Moreover, Mr. McGivern's experience well demonstrates the superior durability of the modern double action Colt and Smith & Wesson guns over the old single action. In Mr. McGivern's speed work he has a very hard time to keep a single action gun in repair for any length of time; whereas the modern Colt and Smith & Wesson guns require no repairs even after years of use. His experience also demonstrated the fact that the single action Army is not strong enough to stand being "fanned" for the speed with which the cylinder is rotated by this method causes it to break the cylinder stop.

When the Single Action Army was first designed, smokeless powder was unknown, hence the older samples of this model are intended only for black-powder use. After smokeless powder became popular, an improved grade of steel was used in the cylinders and other important parts of the Single Action Army and it was tested with a higher pressure than the early samples were. This change was made at No. 160,000, and all Single Action Army Colts with later numbers have been tested for smokeless powder and are intended for use with either black or smokeless.

A few years ago the Army sold many thousands of these revolvers, and at the present time they may be bought from some dealers in second-hand and Army supply goods. Such guns are not advised for the reason that they are often made up from miscellaneous parts and it is not likely that you will get one composed of the original pieces. In purchasing such a gun, look it over and see that all the parts carry the same serial number.

Some of these old assembled guns are fitted very poorly and may be dangerous. In some of them the cylinders line up badly and you never know when one may have been reblued by heating until it is in no condition to stand the strain of modern cartridges or even heavy loads of black powder.

This gun must be loaded one cartridge at a time through a loading gate on the right-hand side. Cartridges are ejected by a sliding ejector rod under the barrel. Never load but five chambers of the cylinder and always leave the hammer DOWN on the empty one. Do not try to carry the hammer down between two loaded chambers, as it starts back too easily and the cylinder then works over until the primer is under the hammer. Do not attempt to carry it with the hammer on the quarter or safety notch; the heavy hammer will fire thin primers when snapped from this position, and it snaps easily. I know of a man who carried his Colt in this manner for years and finally in an argument to prove that it would not discharge the cartridge, shot off his left forefinger while demonstrating.

The following table of dimensions, etc., pertaining to the old Service Single Action Army Revolvers is taken from an old Ordnance manual describing these arms:

Total length	12.5 inches
Length of barrel	7.5 "
Length barrel, later reduced to	5.5 "
Grooves, number of	6
Grooves, width of along their middle lines	.2 inch, flat, tangent to the bore
Lands, width of	.03 to .033 inch.
Grooves, depth of, (uniform)	.005
Twist, uniform left handed, 1 turn in	16 inches.
Bore, diameter of	.445 inch.
Chambers, number of	6
Chambers, diameter of rear end	.485
Chambers, diameter of cone	.482
Chambers, diameter of front end	.450
Cylinder, length of	1.608
Cylinder, diameter of	.65
Height of front sight above axis of bore	.6225
Weight, with 7½ inch barrel	2.31 lbs.

The form of rifling in the modern Single Action Army Colt revolvers differs from that given above for the older guns, and is the same as that on their other .45 revolvers, given as follows in the Ordnance pamphlet on the 1917 revolver:

Bore, diameter of	.445
Rifling, diameter of	.452
Rifling, depth of	.0035
Grooves, width of	.156
Lands, width of	.073

The single-action Army is made in 4¾-, 5½- and 7½-inch barrels. The 5½-inch is the best length as it balances better than the other two. The gun weighs 37 ounces in the .45-caliber. It is made in the .32-20, .38-40, .38 Special, .44 Special, .44-40 and .45 Colt.

Colt and Smith & Wesson .38 Army Revolvers

During the many years that the Army was using the old single action Colt revolvers improvements were gradually being made in firearms sold for commercial purposes. For one thing the double action lockwork had been perfected; and more important, revolvers were arranged for simultaneous loading and ejection, using the swing-out cylinder. Finally in 1892 the Army decided to replace the slow loading .45 single action revolver with the more modern and up-to-date swing-out cylinder double action type, and a board which convened to consider this matter adopted the Colt and Smith & Wesson .38 caliber revolvers as standard. The first Colt model adopted by this board was known as the Model of 1894. There were also successive models known as the Model of 1896, the Model of 1901, and the Model of 1903. These models looked much alike but involved slight changes. The Smith & Wesson revolvers were of the same general type and looked like the Colt except they had a round butt. These Smith & Wessons did not have the front latch on the ejector rod which is a distinctive feature of modern Smith & Wesson guns.

These old Colt .38 caliber revolvers were really not very satisfactory arms. They had several weaknesses, the most serious of which was the frequent failure to line up the cylinder properly with the barrel. This resulted in shaving of lead and inaccuracy. Another trouble was the regularity with which the "hand-spring" became broken so that the cylinder would not rotate. This was usually due to faulty assembly of the side plate, as there is a pin on the side plate against which the hand-spring bears and if care is not taken to put this pin behind the spring in assembling the gun the spring will be broken off the first time the gun is cocked. Part of the trouble in shaving lead, etc. was due to the fact that the cylinder rotated to the left, so that the thrust of the "hand" or pawl which rotates the cylinder tends to push the cylinder away from the frame.

The Smith & Wesson .38 made for the Army were far superior to the Colt guns of that model and were really excellent revolvers. I have been told by Smith & Wesson that they protested against the left hand rotation of the cylinder, but were obliged to make the guns that way to conform with Government specifications. However, by means of superb workmanship and excellent fitting these Smith & Wesson guns were made so that the cylinder lined up satisfactorily and the shaving of lead was avoided.

The difficulty experienced with these old revolvers in having the thrust or rotation tend to push the cylinder away from the frame finally led Smith & Wesson to invent the front latch for the cylinder. Colt also overcame this difficulty in their later commercial models by changing the rotation of the cylinder so that the thrust of rotation tends to hold it against the frame instead of pushing it away.

The board which recommended the adoption of the .38 caliber realized that the stopping power was inferior to that of the .45 but concluded that it was probably sufficient, and stated that this point could not be definitely decided until actual experience was had with these revolvers in war. This experience came in the Philippine Campaign and the .38 caliber revolver was found not to have sufficient stopping power. This led to the adoption of the Colt New Service .45 as will be described next.

Many of these old Colt and Smith & Wesson revolvers were sold to civilian marksmen at a reduced price after they were declared obsolete by the Government and for that reason revolvers of that type will frequently be encountered.

The following dimensions, etc., pertaining to these old Colt .38 Caliber Army revolvers is taken from contemporary Ordnance pamphlets:

Weight of revolver	33	ounces
Total length	11.5	inches
Barrel length	6	inches
Diameter of bore, models 1894, 1896, and 1901	.363	inch
Diameter of bore, model 1903	.357	"
Number of grooves	6	
Width of grooves	.156	inch
Depth grooves	.003	inch
Twist, left hand, 1 turn in	16	inches
Lands, width	.034	inch
Length of cylinder	1.499	inch
Diameter of cylinder	1.52	"
Number of chambers	6	
Diameter of chambers	.3825	inch
Height of front sight above axis of bore	.6045	inch

After the adoption of the .45 by the Government both the Colt and the Smith & Wesson firms continued to manufacture a commercial model similar in size, weight and general appearance to the Army guns described above. These commercial guns were, however, vastly improved over the old Army models and are among the most popular and satisfactory military type arms that can be bought today. The Colt gun of this type is the Official Police and the Smith & Wesson is the Model K or Military and Police. These guns were described in the last chapter and are both arms of the highest excellence.

The Colt New Service Revolver. The U. S. Army Model of 1909

When, as has been mentioned before, the Philippine Campaigns developed the fact that the .38 did not have sufficient stopping power to put an end to the rushes of fanatical Moros the Army was engaged in an endeavor to find a suitable automatic pistol for adoption, and as a result of this experience it was decided that when an automatic pistol was finally adopted it should be of .45 caliber.

The automatic pistol was finally adopted in 1911, but in the meantime the Army had adopted the .45 caliber revolver for special use in the Philippine Islands. This revolver was the regular Colt New Service Military Model and as used in the Army was officially called The .45 Caliber Revolver Model of 1909. It was chambered for the powerful and highly effective Colt .45 cartridge which has a 255 grain lead bullet. The nose of this bullet is somewhat flattened and this adds to its stopping power. This cartridge is far more effective as to shock power and stopping ability than is the .45 automatic.

The Colt New Service Revolver is regularly chambered for the .38 Special, the .44 Special and Russian, the .38-40, .44-40, .45 Colt and .455 Ely cartridges. The gun can be had with 4½, 5½ or 7½ inch barrels and weighs 40 ounces. It is an extremely satisfactory, heavy caliber, military revolver, with high accuracy and very great ruggedness and durability.

The Smith & Wesson .44 Military

Before the World War, Smith & Wesson regularly produced a large frame, military type, double action revolver in the .44 S. & W. Special caliber. This gun called the "New Century" model had the ejector rod completely housed into a protecting rib built underneath the barrel and had an arrangement whereby the cylinder when closed was locked in position at the rear, and in addition the arm of the crane, or cylinder carrier, had a latch to lock it to the frame at the front end. Moreover, the ejector rod was also latched into place at the extreme front end of the housing under the barrel. Pushing forward the latch on the left side of the revolver frame unlocked the three catches above mentioned so that the cylinder could be swung out. This gun was often called the "Triple Lock" model.

However, at the beginning of the World War England and Canada both bought revolvers from Smith & Wesson chambered for the .455 British Service Cartridge and at this time the "New Century" was modified so as to omit the lock at the front end of the crane retaining only the lock at the rear of the cylinder and the front of the ejector rod. At the same time the housing under the barrel for the protection of the ejector rod was removed and only the locking lug under the barrel at the front end of the ejector rod was retained. These two changes were made to make the gun more serviceable by eliminating any possible difficulty in closing should the mud of the trenches get into the space between the crane and the frame or between the ejector rod and its housing. This modified gun was called the .44 Military and is now manufactured by Smith & Wesson under that name.

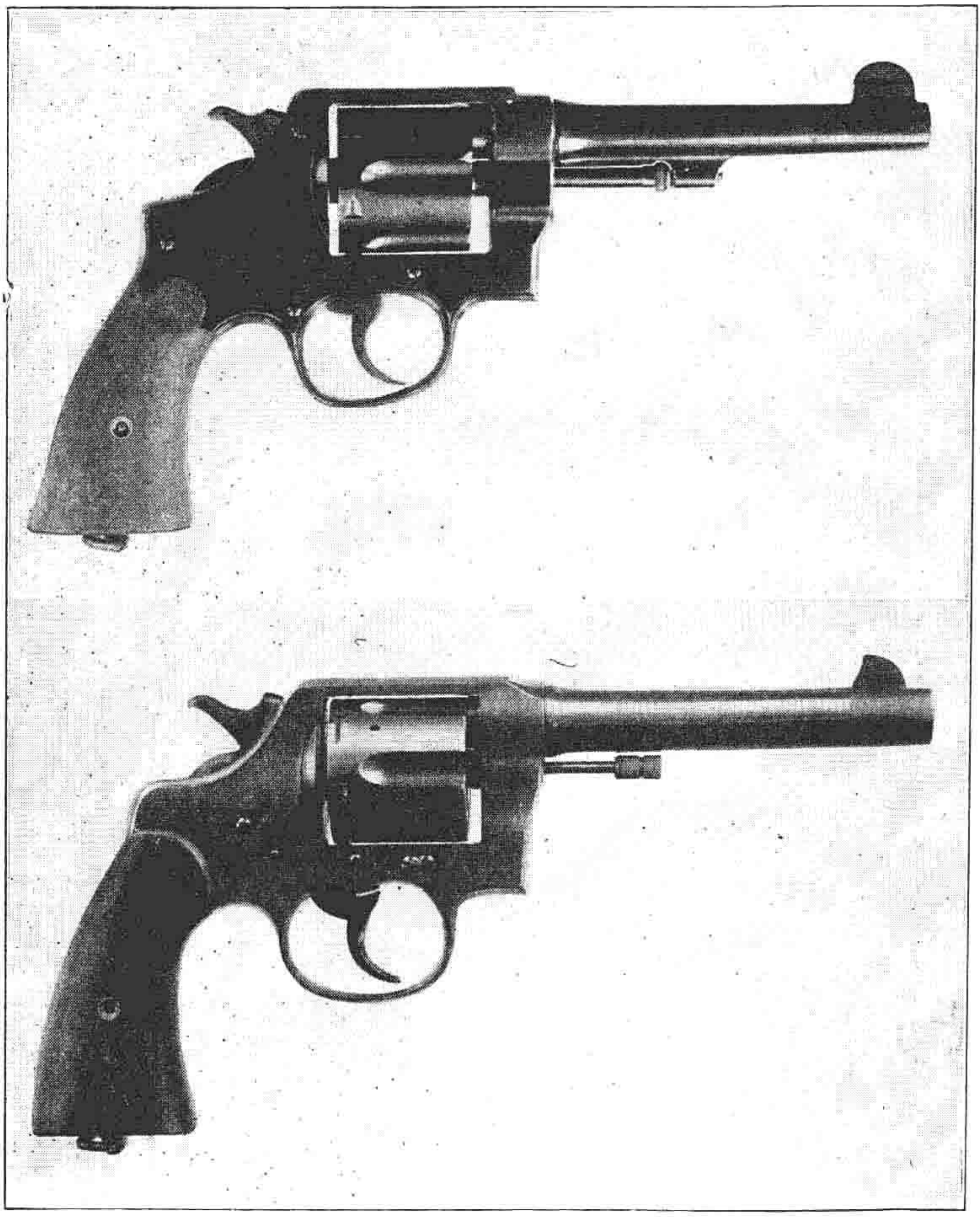
This is a gun of the highest workmanship and of superb accuracy which is still further enhanced by the fact that the gun is made especially for the highly accurate .44 S. & W. Special cartridge. It may be noted, however, that the somewhat less powerful .44 S. & W. Russian cartridge may be used when desired in any gun chambered for the .44 Special. This gun contains a sliding rebound block under the lower surface of the hammer which is designed to prevent the hammer from striking the cartridge except when the trigger is pulled this drawing the rebound block from its position. Thus the rebound block is intended to prevent accidental discharges should the hammer be struck by accident or by dropping the gun, or should the thumb slip from under the hammer in cocking. The gun is made in 5 or 6½ inch barrel and weighs 38 ounces.

This gun modified to take the .45 automatic cartridge and fitted with a 5½ inch barrel became the Model of 1917 revolver adopted by the U. S. Army during the World War, described below.

Model 1917 Colt and Smith & Wesson Revolvers

When the United States entered the World War the standard sidearm of the Army was the .45 Caliber Automatic Pistol, Model 1911, but it soon became evident that it would not be possible to obtain enough automatics to supply the demand. In this emergency the firm of Smith & Wesson suggested using their .44 Military Revolver modified to take the .45 automatic pistol cartridge, using a clip that they had invented to facilitate the quick loading of revolvers.

This clip was a crescent shaped piece of spring steel designed to hold three automatic pistol cartridges. Two clips of three cartridges each could be quickly dropped into the cylinder of the re-



The Model 1917 Service Revolvers. Upper: The S. & W. Lower: The Colt. Illustration shows very well the differences in the respective grips of each make. Note the slightly greater depth and the different "set" of the Colt grip. Individual preference for one or the other of these weapons is generally based upon the "fit" of these grips to the shooter's hold and hand.

volver, thereby greatly reducing the time necessary to reload. This clip also facilitated the extraction of the rimless .45 caliber cartridge, which could not be extracted in the ordinary manner owing to the fact that the extractor would slip over the rim of the cartridge.

This modified Smith & Wesson revolver was tested out at Springfield Armory and found to be very satisfactory. Investigation showed that the Colt New Service Revolver could also be modified in the same way. The regular barrel length on the Smith & Wesson .44 was 6½ inches and that on the Colt New Service 5½ inches, so it was decided to have the barrel length on the modified Smith & Wesson 5½ inches, in order to make the two revolvers uniform in size. An order was then placed for the entire output of the Smith & Wesson factory in revolvers of this type, and a similar order was placed with the Colt Company.

These two revolvers became known as the U. S. Army Model 1917. This model is still manufactured and sold by Smith & Wesson, but at the close of the War the Colt Company discontinued the Model 1917 and returned to their regular New Service.

Whereas it was intended to use the clip with these revolvers for speedy loading and for extraction, it was soon found that the Smith & Wesson did not absolutely require the use of the clip as this gun was constructed with a shoulder at the front end of the chamber, the same as is found in the automatic pistol, and in placing the cartridges in the cylinder the square front edge of the cartridge case stopped against this shoulder so that the clip was not required to prevent the cartridge from going all the way in. It was found that the cartridges could merely be dropped into the cylinder one by one and would then fire in a perfectly satisfactory manner, but, of course, would not eject automatically by pushing the extractor rod as they would when the clip was used. It was found, however, that frequently if the gun was turned up-side-down the cartridges could be shaken out; or they could be pried out with the rim of another cartridge or pushed out with a short stick, or removed in some other manner.

It was found that in the early Colt guns there were no such shoulders, and the cartridges when dropped in would go all the way through, therefore a clip was necessary with the Colt. As soon as this was discovered a change was made in the Colt gun to make it have a shoulder the same as the Smith & Wesson. There were several hundred thousand Colts made, and the first fifty thousand did not have the shoulder, and with these the clip is necessary. With all the other Colts, except the first fifty thousand, and with all the Smith & Wessons, it is not necessary to use the clip except for speedy loading and ease of extraction.

Shortly after the war the Peters Cartridge Company put out a cartridge especially designed for the Model 1917, known as the "Auto Rim." This cartridge is made with both a jacketed bullet and a lead bullet, and is very similar in size to the .45 automatic pistol cartridge except that it has a rim which allows it to be extracted with the regular extractor.

The jacketed Auto Rim bullet weighs 230 grains and gives ballistics identical with those of the .45 automatic pistol cartridge. The lead bullet used with the Auto Rim weighs 255 grains and gives ballistics very similar to those obtained with the old style .45 Colt cartridge. Owing to the fact that a lead bullet is more effective than a jacketed bullet, the lead Auto Rim is the better cartridge of the two. The Remington Company also puts out an auto rim cartridge.

Many users of the Colt Model 1917 wish to change it over to take the .45 Colt Cartridge, and most of them think that this can be accomplished simply by purchasing a new cylinder, but it cannot be done so easily because there are quite a few differences between the Colt New Service .45 and the Colt Model 1917.

The Model 1917 was made on the New Service frame but the cylinder of the M 1917 is shorter than that of the New Service in order to give more headspace at the back of the cylinder. This is necessary because the thickness of the rim on the automatic pistol cartridge, plus the thickness of the steel clip, is considerably greater than the rim thickness of the old .45 Colt cartridge.

In the Colt revolver there is a raised surface on the side plate which holds the cylinder in place when it is swung out in the frame. This raised surface is made to correspond with the rear edge of the cylinder, and as the cylinder is shorter in the Model 1917 than it is in the .45 New Service, the top lug is located at a different point in order to take care of the shorter cylinder. When interchanging cylinders, therefore, it is necessary to have a new side plate. This involves a considerable amount of fitting, not only on the side plate but also on the crane, as each crane is fitted on an individual frame.

For this reason the changing of these cylinders is considered impracticable; besides, there is no good reason for making the change because the ballistics of the lead bulleted auto rim cartridge are almost equal to those of the .45 Colt cartridge, and there is not much to be gained by the change.

However, in response to the demand for changes of this nature, both Smith & Wesson and the Colt Company will furnish new cylinders, when ordered. The guns must be sent back to the factory to have these cylinders fitted. The length of the cylinder on the New Service .45 is 1.62″, on the Colt Model 1917 it is 1.59″, and on the Smith & Wesson it is 1.54″. The overall length of the .45 Colt cartridge is 1.57″, the rim thickness of the old style .45 Colt is 0.05″, whereas that on the .45 auto rim is 0.85″. Thickness of clip is .04.

Another question that sometimes comes up in connection with these revolvers is the desire of someone to use the Model 1917 cylinder in the New Service frame by sliding it onto the crane which is already fitted. The attempt to do this usually fails because the guide ribs on the ejector rods will not quite fit the slots in the cylinder. With a little gunsmithing this difficulty can be overcome, and the Model 1917 cylinder can be used in the 1909 frame by being careful each time that the cylinder is closed to guide it into place by hand, as the cylinder guide on the side plate is too short.

A comparison between the Colt and Smith & Wesson Model 1917 guns shows that they are very similar in general appearance and that they are about equal in accuracy. They both have 5½ inch barrels, but the Smith & Wesson is slightly lighter in weight and the handle of this gun is also smaller. The weight of the Smith & Wesson is 36¼ ounces and that of the Colt 40 ounces.

Numerous tests have been made to determine the relative velocities between the Model of 1917 revolver and the .45 Automatic pistol, both firing the same cartridges. In one test, the average results obtained by firing six guns of each kind showed the following comparative velocities:

Weapon Tested	*Muzzle Velocity*
.45 Cal. Automatic Pistol	800 foot seconds
.45 Colt M 1917 Revolver	813 " "
.45 Smith & Wesson M 1917 Revolver	785 " "

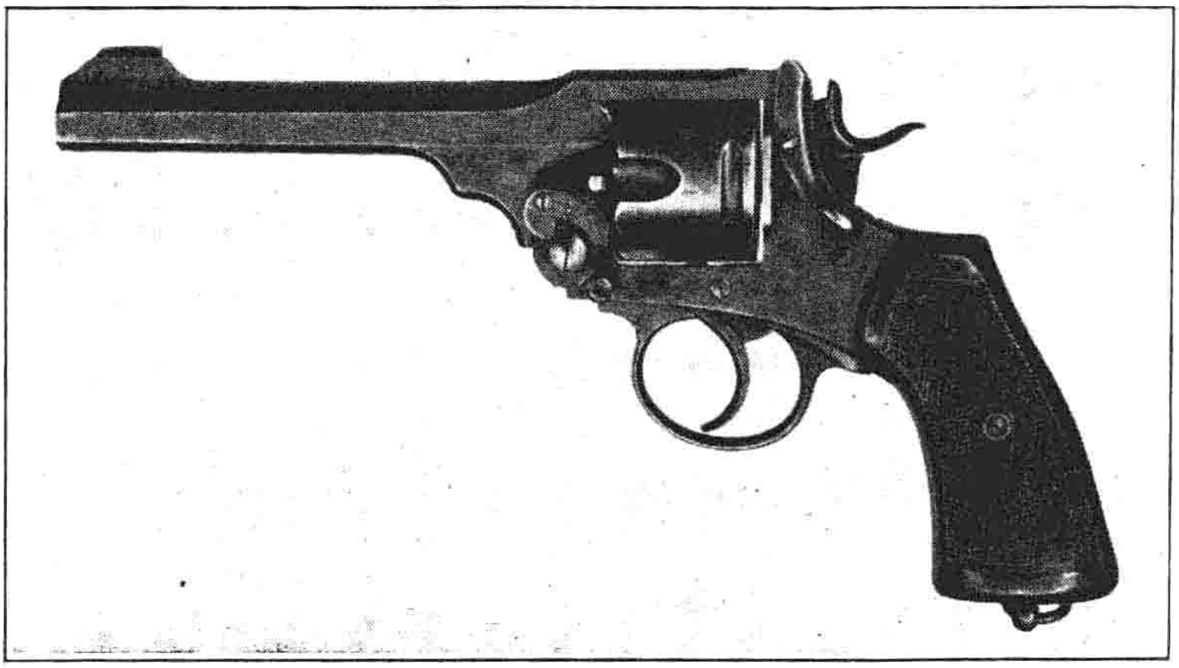
Ordnance Pamphlet No. 1918, describing these two arms, gives the following dimensions:

	Colt	*Smith & Wesson*
Weight	2 lb. 8 oz.	2 lb. 4 oz.
Total length	10.8 inches	10.79 inches
Barrel length	5.5 inches	5.5 inches
Diameter of bore	.445 inch	.445 inch
Diameter of rifling	.452 inch	.451 inch
Number of grooves	6	6
Width of grooves	.156 inch	.157 inch

Depth of grooves	.0035 inch	.003 inch
Twist, 1 turn in	16 inches	14.659 inches
Width of lands	.073 inch	.075 inch
Cylinder length	1.595 inches	1.537 inches
Cylinder diameter	1.695 inches	1.708 inches
Chambers, number	6	6
Chambers, diameter maximum	.4795 inch	.480 inch
Chambers, diameter minimum	.473 inch	.4795 inch
Front sight above axis of bore	.7325 inch	.794 inch

The Webley "Mark VI" Service Revolver, Caliber .455

This is the service sidearm of the British Army. It is a double action revolver of the hinged frame variety, in which the barrel tips up to eject the empty cartridges, and to reload. The latch which holds the action shut is made in the form of a heavy stirrup, which makes the closure very secure. This latch is somewhat on the principle of the one used on the .45 Schofield Model Smith & Wesson Army Revolver used in the Army years ago, but in the Webley, there is an extension, or thumb piece, on the left hand side of the revolver for operating the latch. Safety against firing the gun with the latch not fully fastened is provided by means of a projection on the hammer, which prevents the hammer nose from coming in contact with the primer unless the latch is fully in place.



The Webley .455 Revolver, Mark VI, the service sidearm of the British Army.

The tip-up action offers the advantage that the cylinder can easily be removed for cleaning, and the breech of the barrel is accessible for the same purpose. Moreover, it makes it possible to convert the weapon into a .22 caliber single shot for practice. This is accomplished by removing the cylinder, and inserting a .22 caliber barrel, which fits inside of the regular barrel. This "aiming tube," as it is called, has an ejector of its own, operated the same as the regular ejector of the revolver, by the motion of tipping up the barrel to load. As the point of impact is different for the .22, the aiming tube carries its own sight, attached to a bracket on the tube, so as to slide into position on top of the frame when the tube is inserted in the barrel of the revolver.

Weight of the gun, 2 lbs. 6 ounces. It can be had in 6 inch or 4 inch barrel. It is an excellent heavy caliber military revolver.

The New Webley Mark IV .38 Caliber Military and Police Revolver

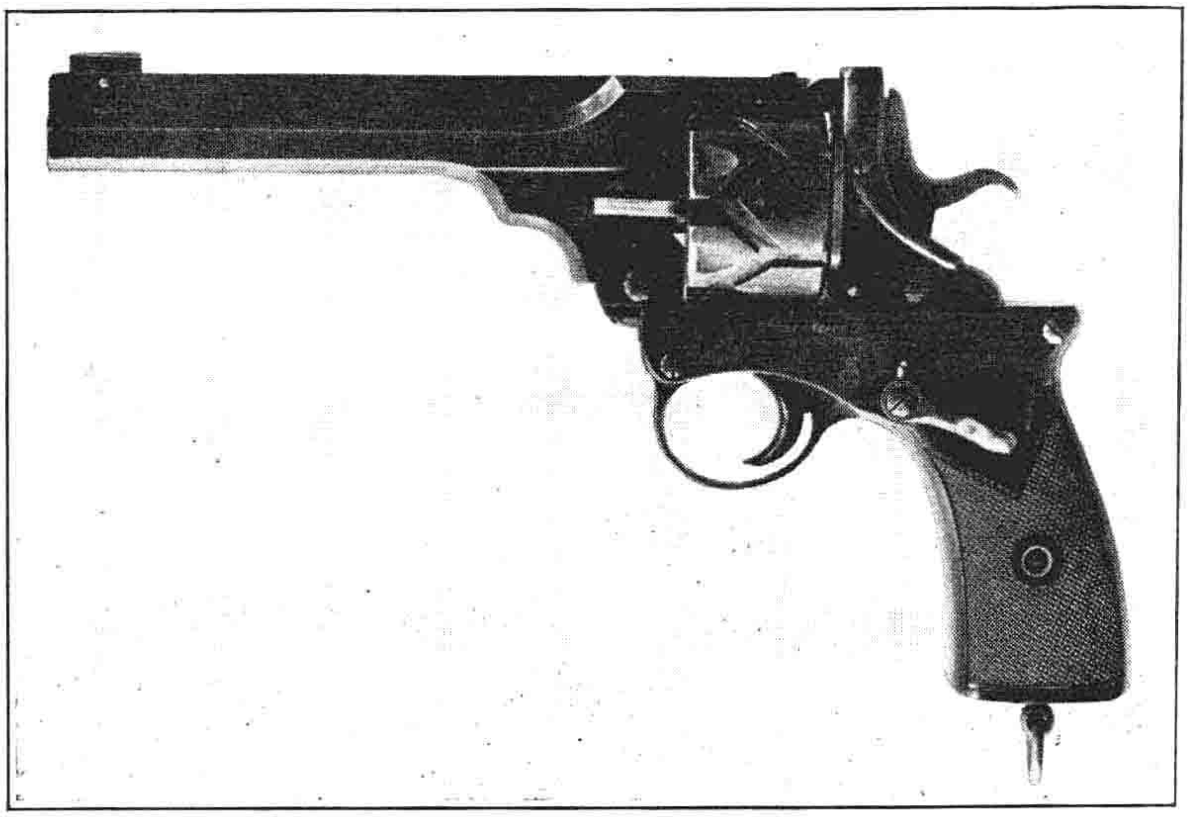
This is a weapon of the same general design and appearance as the .455, but is the latest Webley Pattern, and embodies a number of refinements and improvements. It was designed to meet the demand for a lighter gun than the .455 Service arm, which would combine perfect balance and great accuracy with exceptional stopping power.

This gun is notable for the excellence of its grip, which has a shape superior to that of any American revolver, and is exceedingly comfortable in the hand. In particular, the space behind the trigger guard is large enough to accommodate the second finger of the hand comfortably, which is not the case with any American gun except the Single Action Army Colt. Moreover, the slope of the bottom of the frame is such that this space behind the trigger guard is partly filled up by the metal of the frame, and thus affords a better support for the gun on the finger, without the necessity of using filler pieces, such as have become popular in this country on account of the defective design of our revolvers in this regard.

This excellent revolver, weighing 27 ounces, is chambered to shoot either the .38 S. & W. Cartridge, with 146 grain bullet, or the .38 Webley & Scott Special, with 200 grain bullet. As these bullets differ in point of impact, separate foresight blades are furnished, one to be used with the .38 S. & W., and the other for the .38 W. & S. Special. This model is supplied with 3 inch, 4 inch, or 5 inch barrel. It has an exceptionally light trigger pull. It can also be obtained in .32 caliber, for the .32 S. & W. long or .32 Colt New Police cartridges.

The Webley-Fosberry Automatic Revolver, Caliber .455

This gun stands in a class by itself as being the only automatic revolver in the world. It is a heavy frame military style large caliber revolver, made by Messers Webley & Scott, of Birmingham. In general design, it resembles the .455 Webley Mark VI, as the tip-up action, barrel latch, etc., are the same; but it has the additional feature, not shared by any other revolver, that the recoil is utilized to cock the hammer and rotate the cylinder after each shot, so that all the user has to do is to pull the trigger as desired.



The .455 Webley-Fosberry Automatic Revolver. The cylinder and barrel are adapted to slide on the frame, and the force of recoil makes them move to the rear. When this motion takes place, the hammer is cocked and the cylinder is rotated, leaving the revolver ready for another shot by merely pulling the trigger.

The automatic action is accomplished by mounting the barrel and cylinder together on a piece arranged to slide to the rear, against the action of a spring, on a track located above the trigger guard and handle. A projecting lug in the track engages in cam grooves in the cylinder, so that the rearward motion turns the cylinder and brings the next cartridge into line with the barrel. At the same time, the rearward motion cocks the hammer. A safety lock is provided on the left side of the frame.

This gun can be fired with extreme rapidity; it is quite possible to fire all six shots in one second. It is chambered for the .455 service cartridge; has a six inch barrel, and weighs 42 ounces.

MILITARY AUTOMATIC PISTOLS

At the present time opinion is somewhat divided in military circles as to the relative advantages of the revolver and the automatic pistol as a service side arm. About the time that the United States Government adopted the automatic pistol it seemed as if the revolver was doomed to be replaced entirely by automatics; but twenty-five years have passed since that date and half the nations of the world still use the revolver and at this writing the situation seems somewhat stabilized.

In pocket automatic pistols using relatively low powered cartridges, the breech of the gun is generally kept shut merely by the strength of the recoil spring and the inertia of the moving parts; but in the high powered military automatics some method of locking the breech positively during the explosion, and then unlocking it later so as to allow the mechanism to open and throw out the empty shell, must be provided.

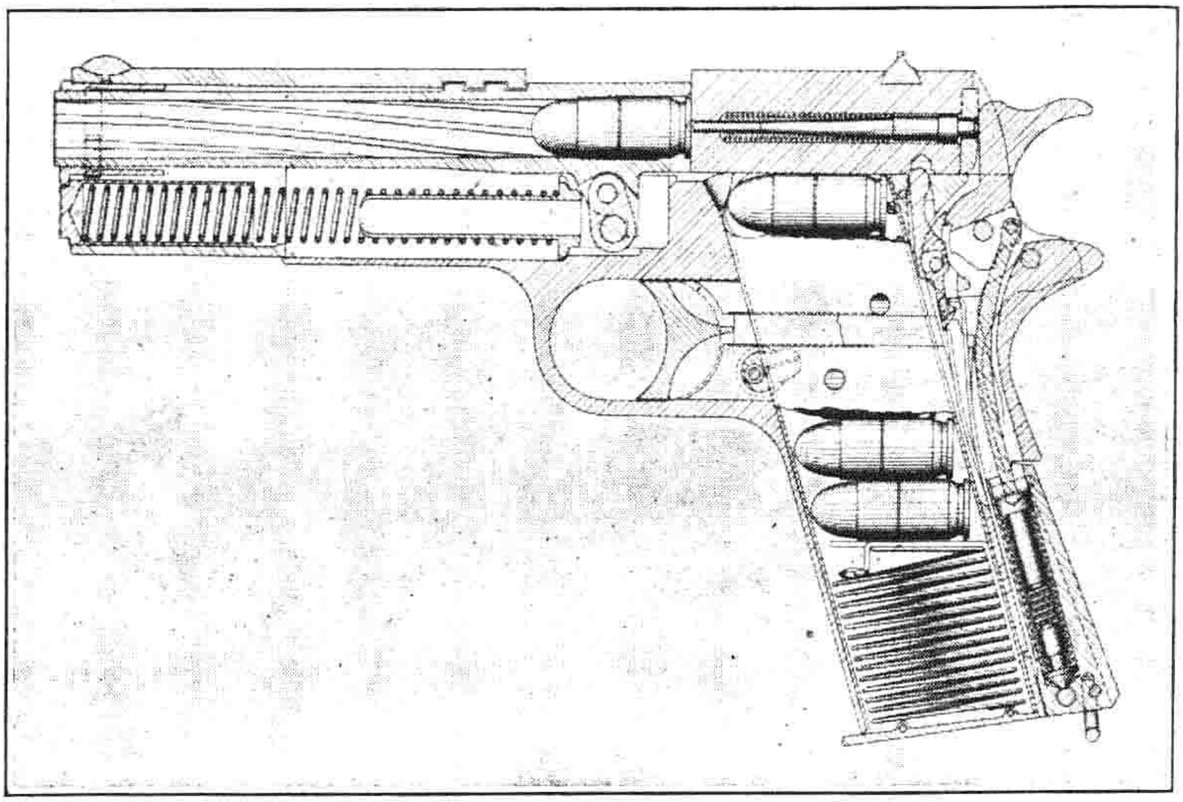
Colt Automatic Pistol, Government Model

This gun, known in the Army as the Model of 1911, is without doubt the finest heavy caliber automatic pistol in the world. It is simple, rugged, and reliable and is less subject to breakages than the average military revolver. Moreover, it is made so that it can be completely dismounted without the aid of tools, and all parts are readily interchangeable.

The Army Automatic is particularly compact, taking up much less space than a revolver of the same power. It is made in .45 caliber with a five inch barrel and has a magazine holding seven shots, in addition to which one can be placed in the chamber, making eight shots in all. The weight of the gun is 39 ounces and the length overall 8½ inches. The gun is so shaped that it fits the hand perfectly, and if the handle is grasped and the arm extended towards any object the pistol will naturally point directly at the object the same as pointing the finger.

An idea of the construction and mechanism of the gun can best be obtained by a reference to the sectional line drawings accompanying this description. The lower part of the gun, consisting of the handle into which the magazine fits is called the receiver, and contains the hammer, the safeties, and the firing mechanism. The upper part of the gun, containing the barrel is called the slide, and is arranged to move backward and forward on top of the receiver. Besides the barrel the slide contains the recoil spring and the firing pin and the extractor. The rearward part of the slide acts as a breech block and rests against the head of the cartridge when it is in the barrel.

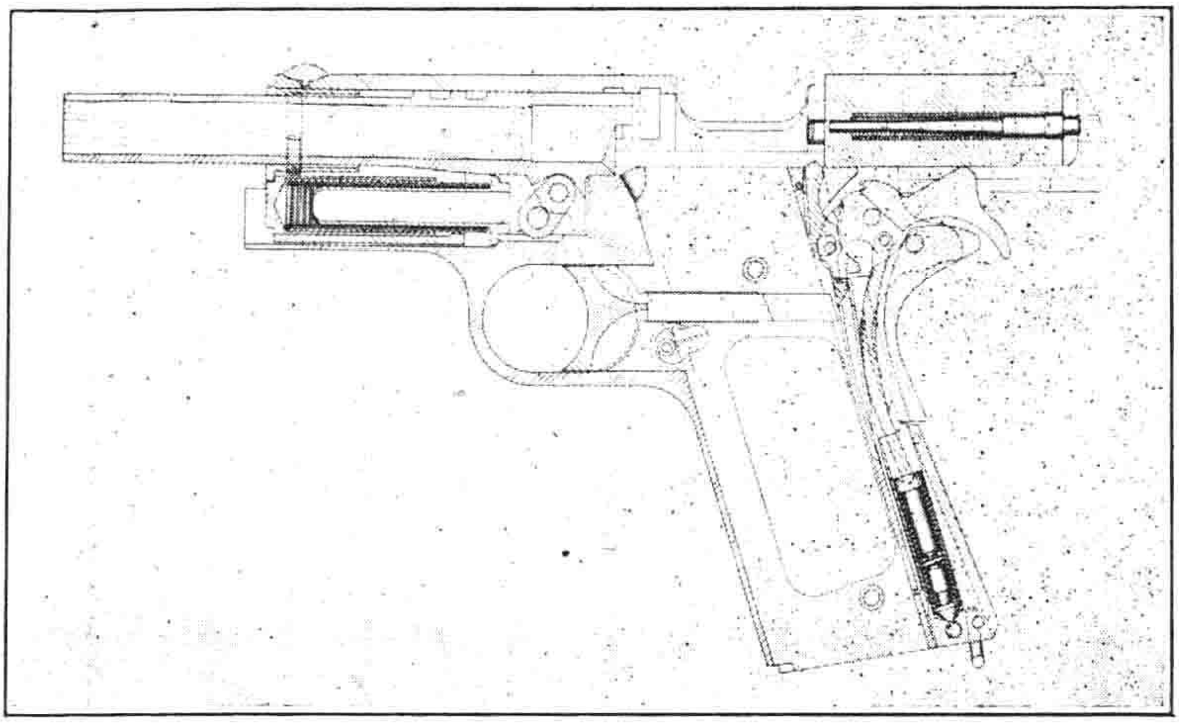
The rear end of the barrel is pivoted by means of a link to the receiver; and on top of the barrel there are several ridges or locking shoulders which fit into corresponding grooves in the top of the slide. When the gun is fired, the head of the cartridge is pressed back by the powder pressure, and tends to separate the breech block from the barrel. However, the breech block, which is part of the slide, is locked on to the barrel by means of the grooves above mentioned, and the powder pressure cannot separate the two parts. However, the pressure does cause the barrel and slide to recoil to the rear together at the same time that the bullet moves forward. As the barrel moves to the rear with the slide, the link pivoting its rear end to the receiver causes the rear of the barrel to swing downward, thus disengaging the locking shoulders on top of the barrel from those in the receiver. At this instant the barrel comes against a stop and cannot move any farther to the rear; but the slide now being unlocked from the barrel is free to continue to the rear.



Sectional view of the Colt .45 Automatic Pistol, Government Model showing the mechanism as it appears in the safe carrying position with the hammer down and a loaded cartridge in the chamber. Note that the firing pin is too short to extend all the way through the breech block, so that a blow on the hammer or the dropping of the pistol cannot cause a discharge. This view also shows the relation of the parts at the instant of firing.

As the slide moves to the rear it extracts and throws out the empty cartridge and also cocks the hammer. It also pushes down a little plunger called the disconnector which disconnects the trigger from the hammer so that the gun will not fire again until the trigger is released and pulled once more.

When the slide reaches the end of its rearward motion, the recoil spring pushes it forward again, and as it goes forward it pushes the cartridge out of the magazine into the barrel and leaves the hammer cocked ready for the gun to be fired again by merely releasing and pressing the trigger. When all seven shots have been fired the slide stays open. If a catch on the left side of the gun is then pressed the empty magazine will fall out, and a new one can be inserted making seven more shots instantly available. After the insertion of the new magazine, a lever on the left side of the pistol just above the trigger guard, called the slide stop, is pressed down and this allows the slide to go shut, putting a cartridge in the chamber and leaving the gun cocked ready to continue firing.



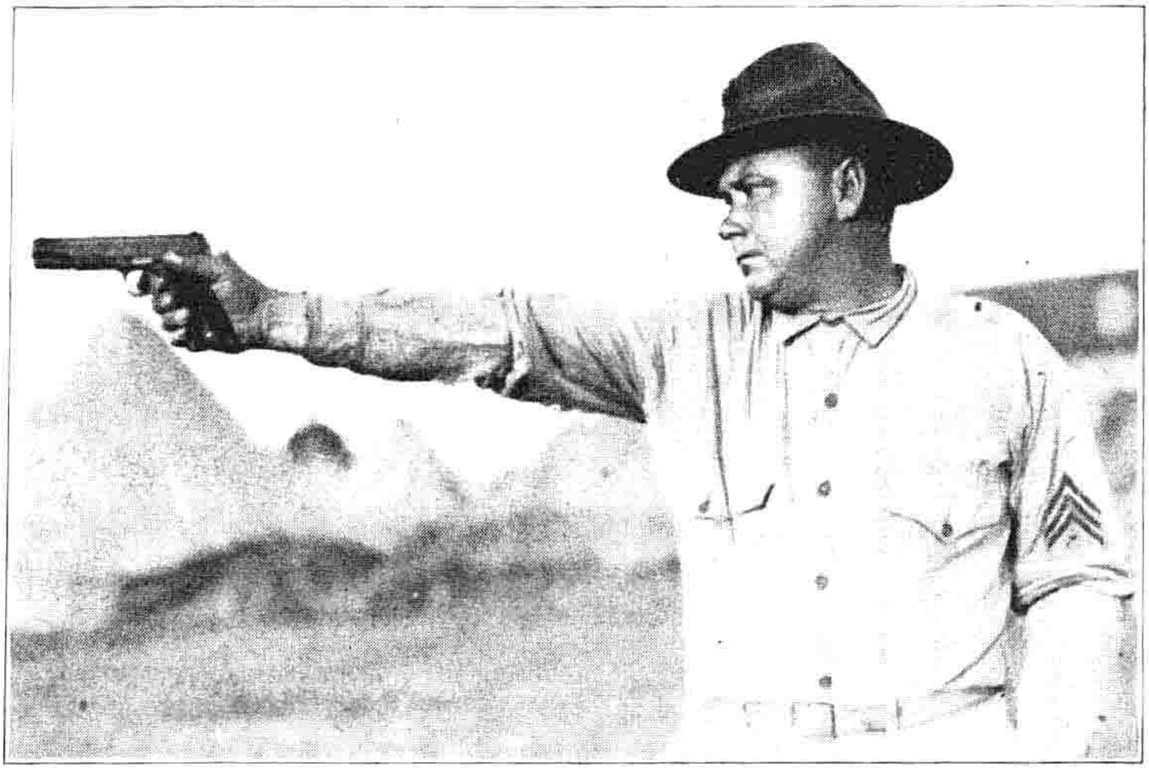
Sectional view of the .45 Cal. Government Model Automatic Pistol, with the slide fully retracted, and the magazine removed for reloading. Immediately on firing each shot, the slide recoils to the position shown, ejecting the empty cartridge and cocking the hammer, after which it instantly returns to the forward position, at the same time pushing a fresh cartridge into the chamber. When the magazine becomes empty, the mechanism remains locked open, in the position shown.

On the left side of the gun there is a safety lock, arranged to be operated with the thumb. When this safety lock is down, the gun can be fired, but when it is up, it locks the hammer in the cocked position. There is an additional safety on this gun consisting of a lever, called the grip safety, on the back of the handle. To fire the gun this grip safety must be pushed in at the same time that the trigger is pulled. This action is entirely automatic as the back of the hand will press the grip safety in whenever the butt is grasped and the trigger is pulled. The grip safety, however, prevents the gun from going off in case something catches on the trigger.

Another important safety feature in this gun is what is known as the flying firing pin. The firing pin is carried inside the breech block and is made shorter than the breech block. Should the hammer be lowered all the way down on the firing pin it pushes the firing pin inside the breech block, but not far enough to make it touch the primer. The only way the firing pin can touch the primer is for it to be struck a sharp blow on the part that projects when the hammer is cocked. The falling hammer is arrested by striking the breech block before the firing pin has struck the primer, but the inertia of the firing pin causes it to continue its motion and strike the primer. In other words the hammer practically throws the firing pin at the primer, and as mentioned above, when the hammer is lowered slowly on to the firing pin, it is pushed inside the breech block where it is housed away safely so that it can neither project enough in front to touch the primer nor enough behind to be struck a sharp blow. Thus with the hammer down and resting on the face of the breech and the loaded cartridge in the chamber, the .45 automatic is perfectly safe and the best way to carry it is with the hammer down on a loaded cartridge. Great care should be used, however, in lowering the hammer on to a live cartridge, and two hands should always be used for this job.

There are two other ways in which the automatic can be carried loaded. One way is with the hammer cocked and the safety on. This is the present regulation way of carrying the pistol in the Army. It has the advantage of avoiding the danger incident to lowering the hammer on a live cartridge, but also has the disadvantage that there is some chance of the safety working into the "off" position through motion of the gun in the holster, especially on horseback. The gun can, if desired, be carried with the hammer at half-cock; but this offers no advantage over carrying the hammer all the way down and is not as safe in case the gun is dropped, as a very sharp blow might conceivably break off the half-cock notch and discharge the gun.

It may be noted here that the gun is constructed so that it is possible to lower the hammer on a loaded cartridge to the half-cock notch with one hand. Many people do not know that this can be done, because it seems that with the finger on the trigger and the thumb on the hammer spur the grip safety will prevent the trigger from being pulled. However, if the hammer is pulled all the way back, the bottom of the hammer spur will strike on the rearward projection of the grip safety and release it, and if the trigger is then held back the hammer can be lowered. This should never be done, however, without pointing the gun in a safe direction, for if the thumb should slip from the hammer at this time, the gun will be discharged. It is better to use two hands, unless the left hand is engaged, as in holding the reins while on horseback. It is the danger of accidental discharge when thus lowering the hammer with one hand while on horseback that caused the Army to change the regulations some years ago so as to require the automatic to be carried with the hammer cocked and the safety on.



The late Sgt. John M. Thomas, U. S. M. C., one of the finest pistol shots the author has ever known and a particularly good shot with the .45 Army Automatic.

With the Colt automatic pistol having the modern commercially made magazines in good condition, malfunctions are almost unknown. Six thousand consecutive shots were fired from one of these Colt automatic pistols in the final Government test without a jam or misfire or a broken part. Some feeding difficulties have, however, been reported with magazines of war time manufacture made under mass production methods. Prior to the war magazines were made by blanking out sheets of steel, bending them to the proper shape, and then welding. During the war, in order to facilitate production, drawn and welded tubes were substituted and the magazines were made of low carbon steel to facilitate the drawing process. The lips of these magazines were then hardened with cyanide in order to give them the requisite stiffness, and in some cases this made them so brittle that cracks developed. The commercial magazines made by the Colt Company at the present time are made of high carbon steel and are also slightly longer, which contributes to a more uniform and ready feeding of the cartridges.

As mentioned before, with the commercial magazines in good condition jams are almost unknown. Most troubles in feeding can be traced to some abuse or poor condition of the magazines of which the following are most common.

(1) Indentation of the side of the magazine from the pressure on the two snap-fasteners of the web magazine pocket in which spare magazines are carried on the belt.
(2) Deformation of the lips. This is difficult to detect by visual inspection when the deformation is slight.
(3) Dirt in the magazine, causing binding of the follower.

Troubles in feeding or functioning may also be caused by the excessive use of oil on the working parts of the gun in very cold climates or in very sandy locations such as in the desert. In such situations the gun should be wiped entirely dry of oil and it will function perfectly with no oil whatever, although, of course, the wear will be greater in this condition.

The .45 caliber automatic pistols manufactured commercially by the Colt Company are vastly superior in finish, workmanship, and fit of the parts to the guns that were turned out for the Army by various factories under rush conditions and by mass production methods during the World War. Guns purchased by the Government are marked "United States Property" on the right side of the receiver. The guns made and sold commercially by the Colt Company have the serial number preceded by the letter "C" and do not bear the Government mark described above.

Colt "Super .38" Automatic Pistol

This gun, the most powerful automatic pistol made, has the same design, mechanism, appearance, etc. as the .45 Government model automatic already described; but the Super .38 is chambered for the high velocity .38 automatic cartridge instead of for the .45. Like the .45 Army model, the gun weighs 39 ounces, has a five inch barrel, and an 8½ inch overall length. The capacity of the magazine is nine shots, which with one in the chamber, makes a total of ten at the command of the shooter. As the design and mechanism is exactly the same, the mechanical description, including safeties, method of loading, method of dismounting, etc. already given for the .45 automatic apply equally well to the .38 Super automatic.

In many ways the .38 automatic pistol cartridge which this gun uses is the finest high powered pistol cartridge made. It has a 130 grain bullet driven at 1200 foot seconds, and giving a muzzle energy of 417 foot pounds as against 340 foot pounds for the .45 automatic. But even more important than the high muzzle energy is the fact that this .38 automatic cartridge is notable for its very deep penetration, which makes it one of the few pistol cartridges that can be relied on to reach a vital spot when it is used for protection against very large animals. Moreover, it has speed enough in the bullet so that sure hits can be made on man-size targets at distances well over one hundred yards.

For years the small calibered but high velocity Mausers and Lugers have been the most popular guns when a pistol capable of very flat trajectory and high penetration was wanted. These German guns have several disadvantages, but they do have speed and penetration. Even at 200 yards they will shoot somewhere near the point of aim, and for this reason they retained sufficient popularity in this country to result in a respectable volume of sales in spite of the very high prices that must be charged for them as a result of our tariff. This popularity existed up until 1929, for until the advent of the Super .38 automatic in that year, we had no up-to-date American pistol that could equal these German guns in ballistics.

However, we have for years had an American pistol cartridge that is superior to either the Mauser or the Luger, and this is the .38 Automatic Colt Pistol Ctg., or ".38 A. C. P." This cartridge was developed for the first military automatic pistol ever made in this country, which was invented by John Browning and put out by Colt under the name of the .38 Military. The Army obtained a number of the then new Colt .38 automatics, as well as a number of nine millimeter Lugers for an extended service test. However, at that time the service side arm was the .38 caliber Colt or Smith

& Wesson revolver using the very low powered .38 Long Colt cartridge and this weak .38 failed to give a good account of itself in the Philippines, so that the Army decided that a larger caliber was necessary, and specified that the automatic to be adopted must be a .45 caliber.

In 1906 extensive tests were made of all available makes of automatic pistols, and the Colt design was selected as being the most promising, although it needed certain refinements. At that time the Colt was made in two calibers: .38 Military and .45 Military. Working with the Ordnance Department the Colt firm improved the .45 mechanically into what is now known as the Model of 1911; and this improved .45 was adopted by the Army. The .38 Military, which was very poor in size, balance, shape of grip, and angle at which the grip meets the body and which did not have the improved magazine catch, slide stop, grip safety, or thumb safety, remained on the market in its old form. The Army had set its stamp of approval on the .45 caliber, and it was only natural that the Colt Company should give all their attention to the new Army model, for it was assumed that any and all buyers of military automatics would want what the Army wanted and so the .38 automatic was left to die.

But it would not die. The ballistics of the cartridge were too good. People found that the new Army .45 fell short at long ranges at which the old .38 Military still held up, and that no pistol cartridge in the world equalled the .38 automatic in penetration. So it happened that there has always been a call for that excellent shooting gun from long range shooters and from people to whom deep penetration seems to be an essential feature. Thus the old .38 Military continued to have a good sale in spite of the fact that its mechanical features were twenty-five years old. It was clumsy and awkward, its grip was at the wrong angle but how it did shoot!

But the Luger is just as old, and even the old style Colt Military beat out the Luger in the early Army tests. Listen to what the board of 1906 said: "From a careful consideration of each weapon and of the tests made by the board, it is of the opinion that the Savage and the Colt automatic pistols possess sufficient merit to warrant their being given a further test under service conditions.

"The Luger automatic pistol, although it possesses manifest advantages in many particulars, is not recommended for a service test because its certainty of action, even with Luger ammunition, is not considered satisfactory."

It was generally recognized for years that the Colt .38 automatic cartridge is the best high powered pistol cartridge made and all that was holding it back was the fact that the weapon in which it was used had not kept pace with improvements in the art. This condition was remedied by the production of the .38 Super automatic in 1929. I received one of the first samples of these guns that the factory turned out and my first shot with it was over the water. My son, Bobby, and I took it to a little headland on the Chesapeake Bay and fired at a floating oil can about 200 yards off shore. The bullet seemed to be right there as soon as the trigger was pulled, and there was a vicious "crack" as the bullet struck the water just under the can. There was no ricochet. Then I fired with the same hold using an Army .45. There was an appreciable interval before the bullet dropped into the water with a dull "plup" about three-fourths of the way out, then ricocheted three times off to the left. A number of shots with both guns showed that the result described was no accident, for the same thing happened each time. Bobby said, "Say, Dad, that first gun you shot certainly lifts my hat when it goes off." The next thing that we did was to step down to the beach and fire into the wet sand. The .45 made a hole about big enough to put two fingers into. The Super .38 made a hole the size of my fist. Bobby regarded the results thoughtfully and remarked, "Gee, Dad, if a fellow got shot with that Super .38 it would be just too bad."

A very important feature of the .38 automatic cartridge is the extremely flat trajectory. The table gives the amount the bullet would drop at the various ranges if the gun were fired with the barrel held horizontal:

Name	*Bullet Weight*	*Ballistic Coefficient*	*Drop of bullet in inches at* 25 yds.	50 yds.	100 yds.	150 yds.	200 yds.	250 yds.
9 mm. Luger	121 **gr.**	.163	1.0	4.2	18	43	78	128
.38 A. C. P.	130 **gr.**	.172	.8	3.4	14.4	33	66	107
.45 A. C. P.	230 **gr.**	.189	1.5	6.8	28	68	122	203

It is apparent from these figures that the .38 Super automatic bullet drops just about half as much as the .45. This table shows how far the bullet would drop if the barrel were held firmly in a horizontal position when the gun is fired. However, this does not tell us how far above a given point the shooter must aim to hit that point, for the gun jumps considerably when fired; and, moreover, the line of sight does not coincide with the line of bore. As a matter of fact, the .38 and .45 automatic pistols are targeted at the factory to shoot into the center of a 2.72 inch bull's-eye at fifteen yards. That means that all the drop at that distance has been neutralized by the sighting, and that the bullet goes above the point of aim sufficiently to strike the center of the bull's-eye when aiming at the bottom. This upward direction in which the bullet starts neutralizes a considerable part of the drop at all ranges. Figured in this manner, the amount in inches that the shooter would have to hold over to hit an object at various distances would be as follows:

Name	*100 Yards*	*150 Yards*	*200 Yards*	*250 Yards*
.38 Super	3½"	16½"	44"	79"
.45 A. C. P.	15½"	50"	97"	171"

This shows for example, that at 150 yards if we aimed at a man's head with a Super automatic, we would hit him about in the pit of the stomach, whereas with a Government model .45 we would probably miss him entirely.

Differences Between the Super .38 and the .45: The fact that the Super automatic is built on the frame of the regular Army .45 has lead many users of the Army gun to ask if it would not be possible for them to have a double purpose gun by buying an extra Super .38 automatic slide and barrel and putting them on the .45 frame. The answer is, that it cannot be done. There are a number of reasons why some of the parts on the Super .38 automatic that are necessarily different from the corresponding parts on the .45. In the first place, the .38 caliber cartridge is considerably smaller in diameter than the .45 cartridge, although it is the same length. Moreover, the .45 is strictly rimless, whereas the Super .38 is not rimless but is what is known as a semi-rim cartridge. At a casual glance it looks like any rimless cartridge, but close examination reveals the fact that the head of the cartridge is just a little bit bigger in diameter than the body. On the other hand, the .45 is the same diameter from one end to the other, including the head. As there is no rim on the .45, and there must be some way to stop the cartridge in its proper place in the barrel so that it will be supported against the firing pin blow, the front end of the .45 cartridge case is left perfectly square and is not crimped into the bullet, and the chamber of the gun is so shaped that there is a sharp shoulder at the front end of the chamber for the cartridge case to rest on. On the other hand, the .38 automatic cartridge is crimped over at the front end, and there is no shoulder at the front end of the chamber. The cartridge is stopped in its position in the gun by a shoulder formed on the overhanging lip at the top of the barrel. The primer in the .38 cartridge is also much smaller than that in the .45.

On account of these various differences it is necessary to make quite a number of parts different. The receiver with all of its contained parts, such as the hammer, trigger, sear, etc., are the same, but there is one piece that goes on the receiver and in practice forms part of it, which is quite different, and that is the ejector. This is a little vertical piece of metal that fits on top of the receiver and is pinned to it, and works in a groove cut in the bottom of the slide. This ejector in the .45 is located at just the right place to strike the rim of the .45 cartridge; but because the .38 cartridge is considerably smaller, this .45 ejector would miss the .38 cartridge entirely. Therefore, in the Super .38 the ejector is made wide, so that it reaches closer in to the center of the gun. This wide ejector would prevent a .45 slide from being placed on a .38 frame; and also the narrow ejector used in the .45 would not work at all with a .38 slide and barrel assembly.

The barrel, of course, is quite different in the .38 from what it is in the .45, as it is smaller in bore and also smaller on the outside at the front end. The barrel bushing is different also. It is made smaller on the .38 so as to fit the reduced diameter of barrel.

The overhanging lip on the rear end of the barrel is longer on the .45 than it is on the .38, and the slide is also made different at this point to fit the barrel which belongs with it. The extractor well or hole in the .38 slide is closer to the center than it is in the .45. The firing pin hole is also different as the .38 uses a smaller firing pin to fit the smaller primer.

The magazine of the .38 differs from that of the .45 mainly in having a rib on each side so as to narrow down the inside space to fit the .38 caliber cartridges. However, the overall dimensions of the magazine are the same on both guns.

High velocity in a pistol cartridge has many important advantages and they are well utilized in the .38 Super automatic. This gun is extremely well thought of in countries where it may have to be used against very large animals. At close ranges the .45 is, no doubt, superior to the .38 Super automatic for most purposes; but it is certain that a man wearing one of the bullet proof vests which have recently become popular in certain quarters would have much more reason to be afraid of the Super .38 than of the .45. Another great advantage of the high speed bullet is that it shoots very close to the mark at reasonably long distances and still has plenty of energy at those ranges. For example, a good shot armed with a Super .38 would have small reason to fear a man 250 yards away armed with a Government .45 automatic.

The chances are that the man with the Super .38 could make the other man lay down his gun.

Luger Automatic Pistol

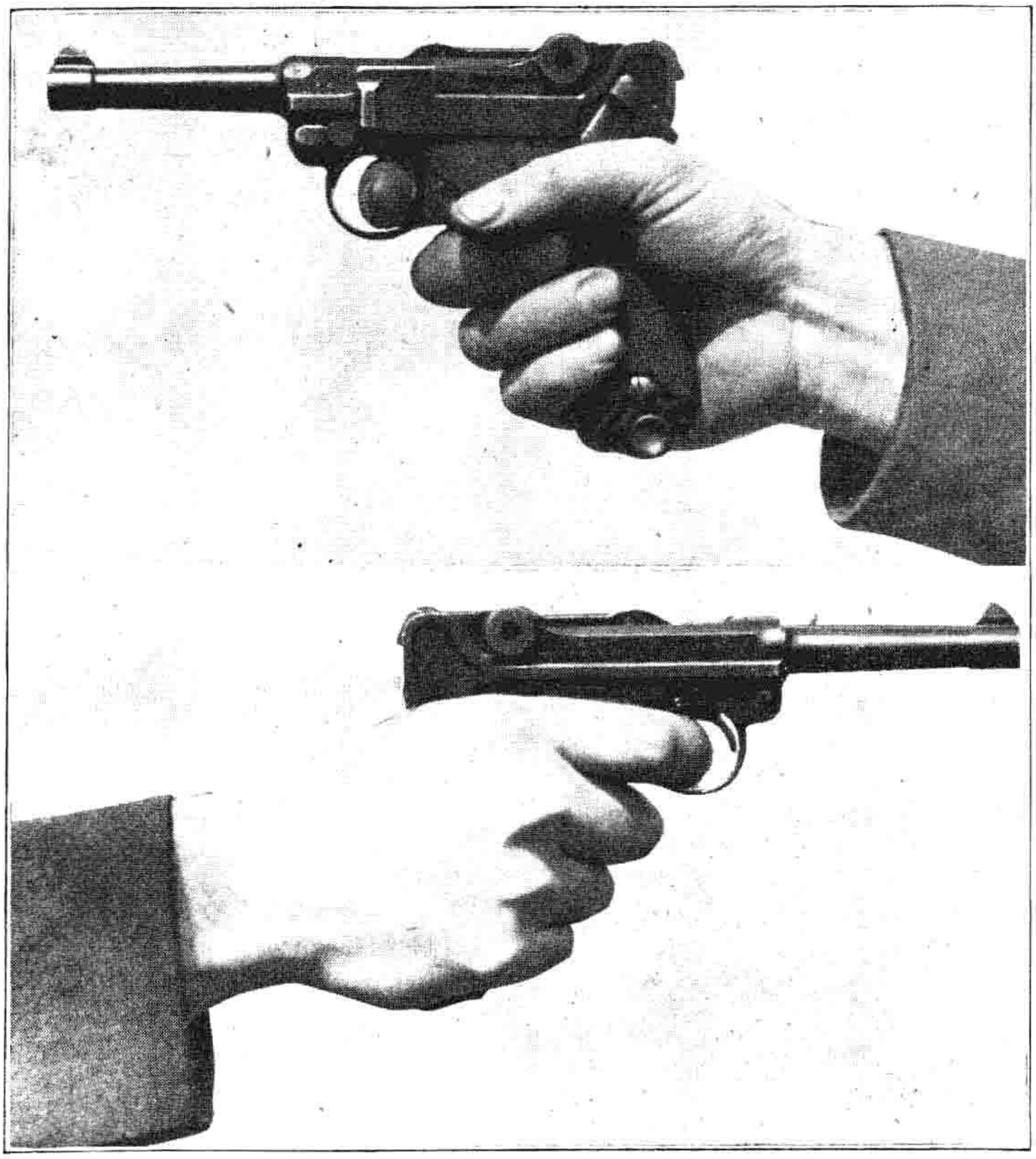
This gun, sometimes called the "Parabellum," is one of the most famous and popular military type automatic pistols in the world and is the service side arm of Germany, Switzerland, Holland, Portugal, Brazil and Bulgaria. The action, which is made on the same principle as that of the Maxim machine gun, was invented by an American named Borchardt who lived in Connecticut. The first models of this gun were called the Borchardt-Luger but the gun has been considerably simplified in the later models and the name has been shortened. The original makers of this gun were the Deutsche Waffen- und Munitionsfabriken, whose monogram "D. W. M." appears on top of the breech mechanism on all Lugers made by that firm. Guns that do not have this monogram are war-time Lugers made by other manufacturers.

The outstanding feature of the Luger is its neat appearance and excellent balance. It is rather light in weight for as powerful a gun as it is. The standard Luger weighs 30 ounces, which is approximately 9 ounces lighter than the Colt. All mechanism of the gun is contained in the part that lies directly above the hand and the barrel is comparatively light. For this reason the balance is exceptionally good. The gun is "muzzle-light" as compared with almost any other automatic pistol. It is the most "natural" pointing of any of the automatics. The angle of the grip to the barrel is very much greater than that of most automatic pistols, and this is one feature that adds to the natural pointing of the Luger. The gun is neat, compact, powerful, clean shooting, accurate and extremely well balanced. For these reasons it has been one of the most popular automatic pistols ever manufactured.

One very bad thing about the Luger pistol is the miserable trigger pull. This is due to the fact that the mechanism which pulls the trigger must work around several corners and for this reason the trigger pull is very hard to work over, to make it even passably good.

As for accuracy, the Luger is excellent, provided you get good ammunition and a good gun. The ordinary 4-inch barrel model generally shoots high and somewhat to the left as it is received from the factory. The longer barrel models—6-inch, 8-inch and 12-inch—generally are sighted so that they shoot about where they are pointed.

In general I have not found the Luger action to be as safe from jams as the Colt action. The main troubles are either failures to open entirely or failures to close entirely. Nearly every jam in the Luger can be traced to a variable quality of ammunition. The most important thing about this gun is to get good strong reliable ammunition. If you are sure of the quality of your ammunation, the gun will generally perform well mechanically.



The Luger Automatic Pistol. This weapon has enjoyed a very great popularity which is largely due to the very graceful shape and the excellent balance. It is a gun which can only be grasped in the right manner, as shown above.

An interesting and useful feature found on many Lugers is the indicator showing whether or not the gun is loaded. This indication is accomplished by means of the extractor, which remains in a raised position above the breech block when there is a cartridge in the barrel, and on the raised side of the extractor is the word "Loaded" or "Geladen." On guns intended for the American trade this marking was in English, and on guns intended for use in Germany it was in German.

There have been a great many different variations in the Luger model. Among the variations may be mentioned the following: In the earlier guns the action spring was a flat leaf spring made of several leaves fastened together. In the later guns it is a spiral spring. Some models have a catch on the right-hand side of the middle pivot of the breech block to hold the breech shut until the barrel has recoiled to the rear, thus preventing the breech from accidentally becoming partly opened. In the later models with the stronger action spring this has been omitted. Some models were made with a catch to hold the gun open after the last shot was fired. In others this catch is not incorporated. In some models the thumb safety pushes up to make the arm safe; in other models it pulls down to the safe position. Some models have a grip safety, others do not. In some models the markings for "safe" and "loaded" are in English; in others they are in German. Some models have an eagle stamped on the receiver just back of the barrel; others do not have it.

The genuine Lugers made today by D. W. M., and sold by A. F. Stoeger, as well as the pre-war Lugers, are of excellent workmanship and material and are in every respect high class arms. However, during the World War guns of the Luger pattern were manufactured under stress of necessity in many various factories under mass production methods and many of these are of very indifferent quality. Moreover, after the war this country was flooded with Lugers of the very poorest quality, many of which were miserable makeshifts apparently assembled from old components left in various factories when the war ended and most likely rejected as unsuitable for military use. It is, therefore important to be able to tell a war-time Luger from one made before or after the war. I have heard many rules quoted as to how to tell the war-time Lugers from the others, but I know of no rule that is infallible. For example, it is said that Lugers not made during the war had an eagle on the rear of the receiver, while the war period Lugers do not. This is not infallible as the only Lugers that had this eagle on them were those specifically manufactured for export to America. Again it is stated that the extractor indicator is marked "Geladen" on war-time guns and "Loaded" on the others. This also is not infallible. The "Loaded" sign was placed only on guns intended for export to

English speaking countries. Many excellent pre-war guns are marked "Geladen." It is said also that on the earlier guns the stocks are made of a dark colored American walnut while on the war-time ones they are made of a very much lighter colored wood. I have an excellent Luger which dates from 1910 which has no eagle on the receiver and has the right stock made of American walnut and the left one of Circassian walnut. It is also said that the war-time Lugers have the attachment on the butt for fastening on the holster stock while this is not on the pre-war ones. The Lugers made today do have this attachment and the ones made before the war generally do not whereas some war-time guns have the attachment and some do not have it.

Thus it will be seen that there is no reliable rule; the best indication is the general finish and workmanship of the gun. Guns that do not have the D. W. M. monogram on them or that have a date on the breech block or have a rough finish on the outside with a grayish appearance rather than the dull satiny black are probably of war-time manufacture and should be shunned.

At the present time the sole agent for the Luger pistol is A. F. Stoeger, Inc., 507 Fifth Avenue, New York. The guns sold by Stoeger today are of excellent quality. When the safety lever is "on" the word "Safe" appears. When there is a cartridge in the chamber the extractor projects above the breech block and shows the word "Loaded." On top of the breech block appears the monogram D. W. M. On the right side of the barrel extension appears the words "A. F. Stoeger, Inc., New York" and just above these words the marking "Germany" in small letters. On the right hand side of the receiver is the inscription "Genuine Luger—Registered U. S. Patent Office."

The Luger is made in both 7.65 millimeter, or .30 caliber, and in 9 millimeter or .38 caliber. Both Luger cartridges have very high velocity, flat trajectory and much penetration. The .30 caliber size is made with a metal jacketed bullet with a rounded point, having about 1200 foot seconds velocity and weighing 93 grains. The 9 mm. has 124 grain, flat pointed jacketed bullet with a standard velocity of 1050 foot seconds. Recently, however, an improved high velocity 9 mm. Luger pistol cartridge has been brought out by Remington which has a velocity of 1210 foot seconds. The 9 mm. bullet is in the shape of a truncated cone and its flat point adds greatly to the stopping effect.

The Lugers are made with four inch, six inch, and eight inch barrels in the 9 mm. caliber and with 3¾ inch, 4½ inch, and 6 inch barrels in the .30 caliber. The shorter barrels have a fixed rear sight at the back end of the breech toggle. The long barrel models have the rear sight, adjustable for range, located in front of the breech mechanism. The weight of the short barrel models is 31 ounces in both calibers.

. Carbine barrels of 10, 12 and 16 inch length can also be obtained for these guns but the functioning of these longer barrels with ordinary ammunition is not reliable and they are principally suitable for single shot work although sometimes a special cartridge loaded to higher velocities especially for the Luger carbine can sometimes be obtained. These cartridges are distinguished by a black case instead of the ordinary brass colored one.

Modern Lugers have a fitting on the grip for the attachment of a wooden shoulder stock.

In common with the other high powered, military automatics, the Luger has a fully locked breech mechanism which opens only after the barrel has recoiled a short distance. Behind the breech block is a toggle joint, and the rear pin of this toggle is fastened in the barrel extension. The breech block and the two levers of the toggle are normally in a straight line. When the cartridge is fired the thrust of the recoil comes on the breech block and is transmitted through the toggle levers to the pin which holds them to the barrel extension; hence the barrel and breech block are forced to recoil together. After moving back approximately one-quarter inch the center part of the toggle joint strikes on the sloping part of the frame, which breaks the toggle, and as soon as the levers are out of line with each other the toggle is no longer locked and the breech opens.

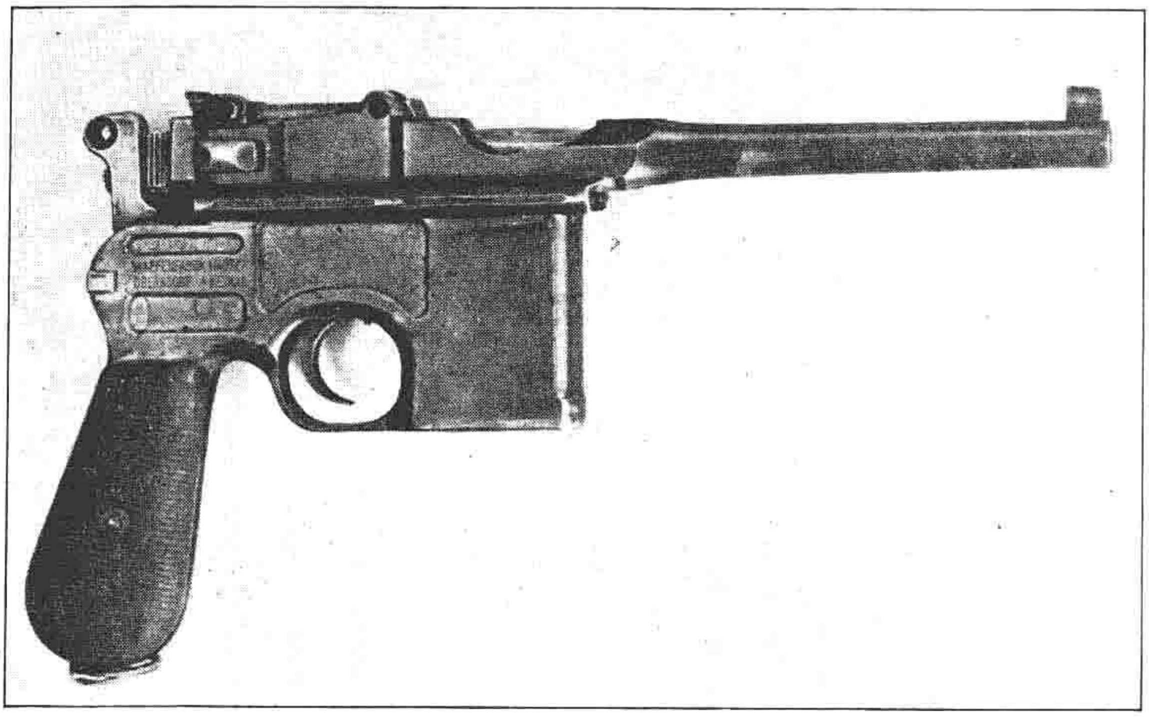
.22 Caliber Attachment for Luger Pistol

A. F. Stoeger, Inc., the importers of the Luger pistol market a .22 caliber insert barrel, automatic breech block, and .22 caliber magazine which can be attached to the Luger pistol to convert it to a .22 caliber automatic. This attachment is very useful for target practice, small game shooting, etc. By the use of this relatively inexpensive attachment the user of the Luger pistol is enabled to obtain unlimited practice at small expense.

The Mauser Automatic Pistol

This is a very famous gun and has for years been used all over the world especially by explorers and those who live in the wilder and less civilized parts of the earth. One of its great advantages is that it uses the highest velocity cartridge made whose ballistics resemble those of a rifle more than those of any other pistol. Moreover, the holster in which this pistol is carried is made of wood and is so shaped as to form a rigid and efficient shoulder stock which can instantly be attached to the handle of the pistol, thereby converting it into a highly accurate carbine with which long range shooting can be done much more effectively than it can with any other hand gun.

The very great penetration of this pistol is shown by a recent test of armored vests conducted by the author. It is interesting to note that with no other pistol or revolver was penetration secured but in every instance in which the Mauser pistol was used the overlapping steel plates of the vest were entirely perforated. The only effect of the heavy .45 Colt revolver with lead bullet, and of the .45 automatic was to dent the plate. Even the Super .38 automatic failed to secure penetration.



Mauser Automatic pistol, caliber 7.63 mm. It is one of the earliest automatics developed.

The gun is twelve inches in length overall, has a 5¼ inch barrel, a magazine holding ten shots, a rear sight adjustable for elevation, and graduated from 50 meters up to 1,000 meters, an outside hammer and a thumb safety. Weight of the gun is 45 ounces.

When the gun is attached to the holster it is twenty-five inches overall; when placed in the holster the overall length is fourteen inches and the weight is 3 lbs. and 12 ounces.

The gun is made principally in 7.63 mm. or .30 caliber; but at one time it was made in 9 mm. for a 9 mm. Mauser cartridge, During the war, however, a number of these 9 mm. Mausers were chambered for the Luger pistol cartridge and such pistols are distinguished by the figure "9" carved into the wooden stock and usually painted red. The gun is now made only in the .30 caliber.

The 7.63 mm. Mauser cartridge has an 86 grain bullet with a velocity of 1323 foot seconds. An accurate range of 1,000 yards is claimed for this weapon with the shoulder stock.

The gun is characterized by an exceptionally clever design of mechanism with the total avoidance of pins or screws in the working parts and the workmanship is of the highest quality throughout.

The original Mauser pistol above described is known as the model of 1899, but recently some slight changes have been made, including a lever by which the gun can be made full automatic so that all shots are fired with one pull of the trigger. This new gun is called the 1932 model and is so arranged that a twenty shot magazine can be used in place of the regular ten shot magazine when desired. This gun, model 711, comes under the special restrictions governing the sale of machine guns which makes it a felony to keep for sale, offer or give a machine gun to any person except regularly constituted or appointed state or municipal police departments, sheriffs and policemen and other police officers and to state prisons, penitentiaries and county jails, and military and naval organizations. While this law at present applies only to the state of New York, the importers of the Mauser pistol, A. F. Stoeger, Inc., have extended these provisions to the whole of the United States and will sell this model 711 pistol with the automatic feature, only to constituted authorities. However, this pistol is also made without the automatic feature as model 712 and this model can be sold to any person who can legally purchase any other pistol or revolver.

The Mauser has a locked breech mechanism, consisting of a long sliding breech block in a barrel extension. The breech block is locked to the barrel extension by means of a locking bolt which engages in shoulders under the breech block and is held up in place by a cam on the frame.

When the gun is fired, the barrel, barrel extension and breech block move to the rear together for a short distance, when the locking bolt is pulled down by means of a cam, and the breech block then continues to the rear by itself. The gun remains open after the last shot and exposes the magazine ready to receive ten cartridges which are furnished in a clip. To load, these cartridges are stripped downward out of the clip into the magazine;

then when the clip is pulled out the breech block goes shut and the gun is loaded.

The .455 Webley Automatic

The official name of this gun, as it is written in Great Britain, is "Pistol Self-Loading, .455 Mark I." It is made by Webley & Scott, Ltd., of Birmingham. The most striking feature in the appearance of this gun is the generally square outline, and the fact that the handle sticks more nearly straight down than it does in our own Army automatic. The grip appears disproportionately long, and the gun seems short from front to rear, so that the impression as a whole is that of a stubby weapon with a very long handle. The grip safety is also very prominent, and sticks out fully half an inch in the rear of the handle, which is quite a bit thicker from side to side than that of our Model 1911 automatic.

The hammer has the same shape as that on the Mauser automatic, which is not bad, and certainly has the advantage of not biting the hand that holds the gun, as our automatic does at times.

While a glance would lead one to believe that the dimensions of the Webley & Scott are radically different from those of the U. S. Model 1911, this is something of an optical illusion, as the following measurements will show:

	W. & S	*U. S.*
	2 lb. 7½ oz.	*2 lb. 7 oz.*
Over-all length	8½ in.	8½ in.
Over-all depth	5½ in.	5⅜ in.
Capacity of magazine	7 shots	7 shots
Weight of bullet	220 grains	230 grains
Length sight radius	7¼ in.	6⅜ in.
Barrel length	5 in.	5 in.

A casual inspection of the outside of the British gun shows the following features: Front sight is square, a better shape for accuracy than our type, but more likely to catch in the clothes or holster, and therefore not so good for service. Rear sight is adjustable for windage, but not for elevation. Magazine release is under the butt; not so conveniently located as ours, and not adapted to ejecting the magazine with one hand. The slide remains back after the last shot, and is conveniently released by a large catch on the left side. The magazine is of a more sturdy construction than that in the U. S. Model 1911, and the lips at the mouth of the magazine look better able to stand service without deforming.

A grip safety is provided, but there is no hand-operated safety lock. The firing pin is made to operate by inertia, like the .45

Colt, and is shorter than its housing, so that the hammer may with safety be carried lowered with a cartridge in the chamber. The extractor is on top, and the ejection is straight up and forward, a marked improvement over the vicious backward ejection of the Army Model Colt automatic.

The rifling is six grooves right-handed and with a much sharper twist than that of the left-handed rifling in the Government Model Colt. The gun has a large comfortable grip, and feels pleasant to aim or shoot; but the angle of the grip is such that there is a natural tendency to point low. In this respect it is inferior to the Colt.

There are several novelties in the construction of this pistol. One that is stressed in the catalogue is the ability to use the pistol as a single-shot weapon, at the same time that the loaded magazine is in place and ready for instant use. This is made possible by having two retaining notches in the magazine, one above the other. When the magazine is pushed all the way in, the catch locks in the lower notch, and the gun is ready for rapid fire. On the other hand, if the magazine is pushed only part way in, so that the catch locks in the upper notch, the pistol can be loaded with single shots, and after each shot the slide will remain open ready for another cartridge to be inserted. The magazine remains in the handle, but down out of the way. If rapid fire is desired, an upward push on the magazine locks it in place for action.

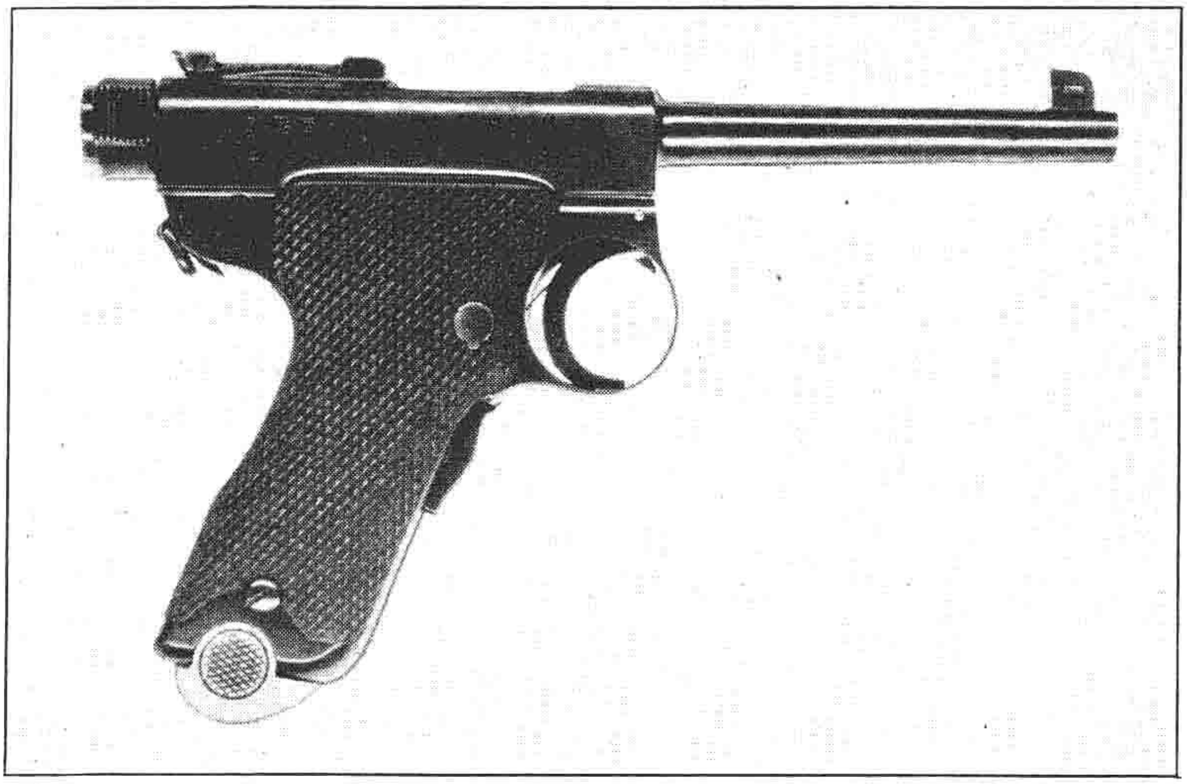
An interesting feature is the extremely rapid take-down arrangement. The action is held shut by the tension of a flat spring which is inside the handle under the right-hand stock. The pressure of this spring is exerted against a hardened-steel pin, which extends transversely through the breech, called the "recoil lever bar and breech stop." On the right-hand side of the frame is a small stud with a milled head. This piece is called the "recoil lever stop," and its purpose is to lock the recoil spring out of action.

To disassemble the pistol, the breech is pulled about a quarter of an inch to the rear, and the recoil lever stop is pressed in, thus locking the spring out of action. The breech is then pushed forward again, and the breech stop (which is now loose, since the recoil spring is locked out of action) is pulled out as far as it will go. This removes it from the path of the shoulders on the frame against which it would normally strike, and at the same time it can not be pulled all the way out and lost because of a screw working in a groove provided for it. The displacement of the breech stop leaves the breech free to be drawn to the rear, which releases the barrel entirely, so that it can be lifted or shaken off. The breech can then be pushed forward off the frame.

The description makes this operation seem longer than it really is. It can be performed in about one second, and is the quickest take-down I have ever seen. It is very much quicker and easier than the corresponding operation on the Colt. In fact, this take-down operation can be done so quickly that it appears as if the operator had merely jerked back the slide and tossed the barrel off the frame. The very great ease with which the barrel can be removed is a strong point in favor of the gun, because it makes cleaning so easy that there is no temptation to shirk this duty.

Japanese 8 m/m Automatic Pistol, "Nambu" Pattern

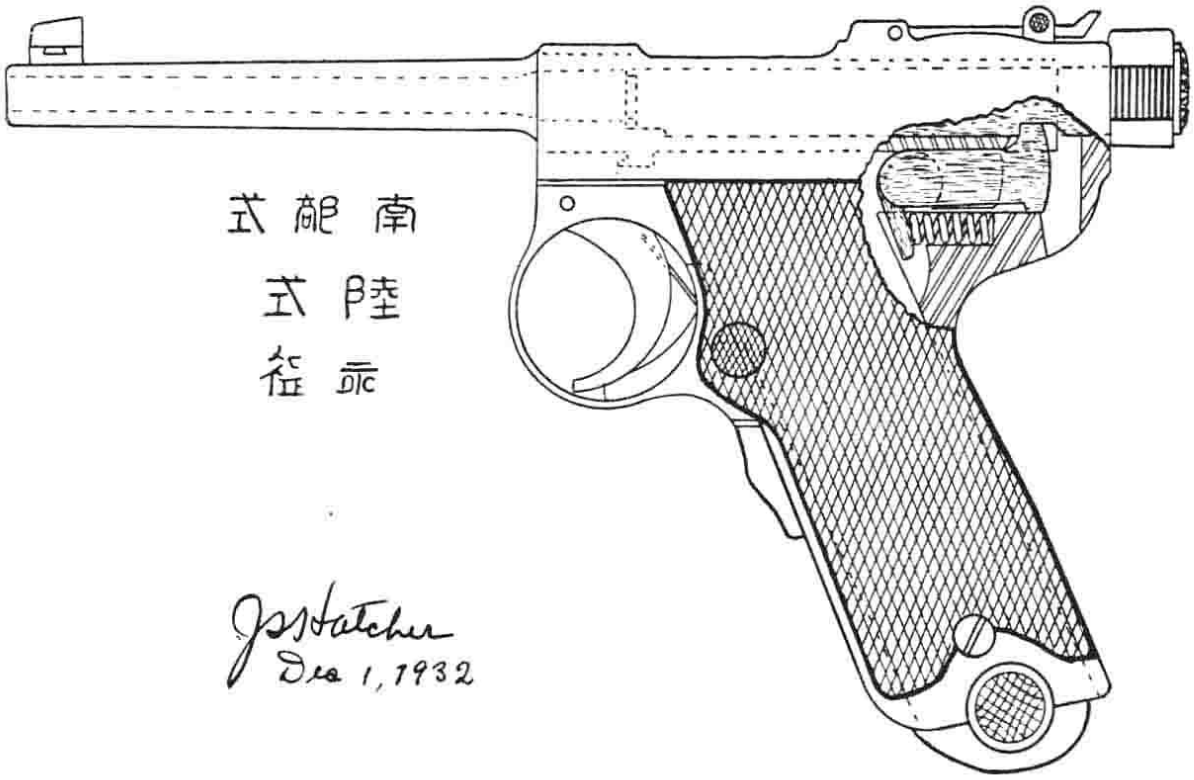
This gun is not sold in America, but occasionally samples will be seen in the hands of travelers who have been in Japan. The gun resembles the Luger in appearance, size, and balance, which is excellent. It uses a cartridge which resembles the .30 caliber Luger cartridge in appearance, but the size is slightly larger, being 8 mm., or .32 caliber, instead of 7.65 mm. as in the Luger. The bullet weighs 102 grains, smokeless powder charge 4 grains.



Japanese 8 m/m "Nambu" pistol. This weapon, which resembles the Luger in shape and outside appearance, has a mechanism of distinctive design which is entirely different from that of any other automatic.

The pistol comes in a wooden holster stock, which attaches to the butt of the gun to form a carbine. The holster is made only long enough to carry the pistol, and as this does not make it long enough to serve as a satisfactory shoulder stock, it has a telescoping section, which pulls out to make the length correct for use as a stock. There is a grip safety on the front of the handle, under the trigger guard. Rear sight is adjustable for range.

While the gun resembles the Luger in appearance, the mechanism is very different in action. The breech block is locked firmly to the barrel extension by a locking bolt pivoted so that it can swing up to lock the parts, or down to unlock them. This down swing cannot be accomplished, however, unless the barrel and breech block have moved some distance to the rear. Therefore, when the gun is fired, the barrel, and the breech block, locked together, move to the rear until the locking bolt reaches a cut in the frame which allows it to swing down and unlock the breech block from the barrel. When this happens, the barrel stops and the breech block travels on to the rear, ejecting the empty cartridge. The spring then pushes the breech block forward, feeding another cartridge from the magazine into the chamber, and pushing the barrel forward to the position where the barrel and breech block are again locked. The entire mechanism can easily be dismounted with the hands, without the use of tools. The gun is very cleverly designed, and well put together, and is a good high-velocity small caliber military automatic.



Sketch made by the author to show the method of locking the breech in the Nambu Pistol. The markings which appear on the gun are also shown.

CHAPTER 4

POCKET AND HOME DEFENSE HANDGUNS

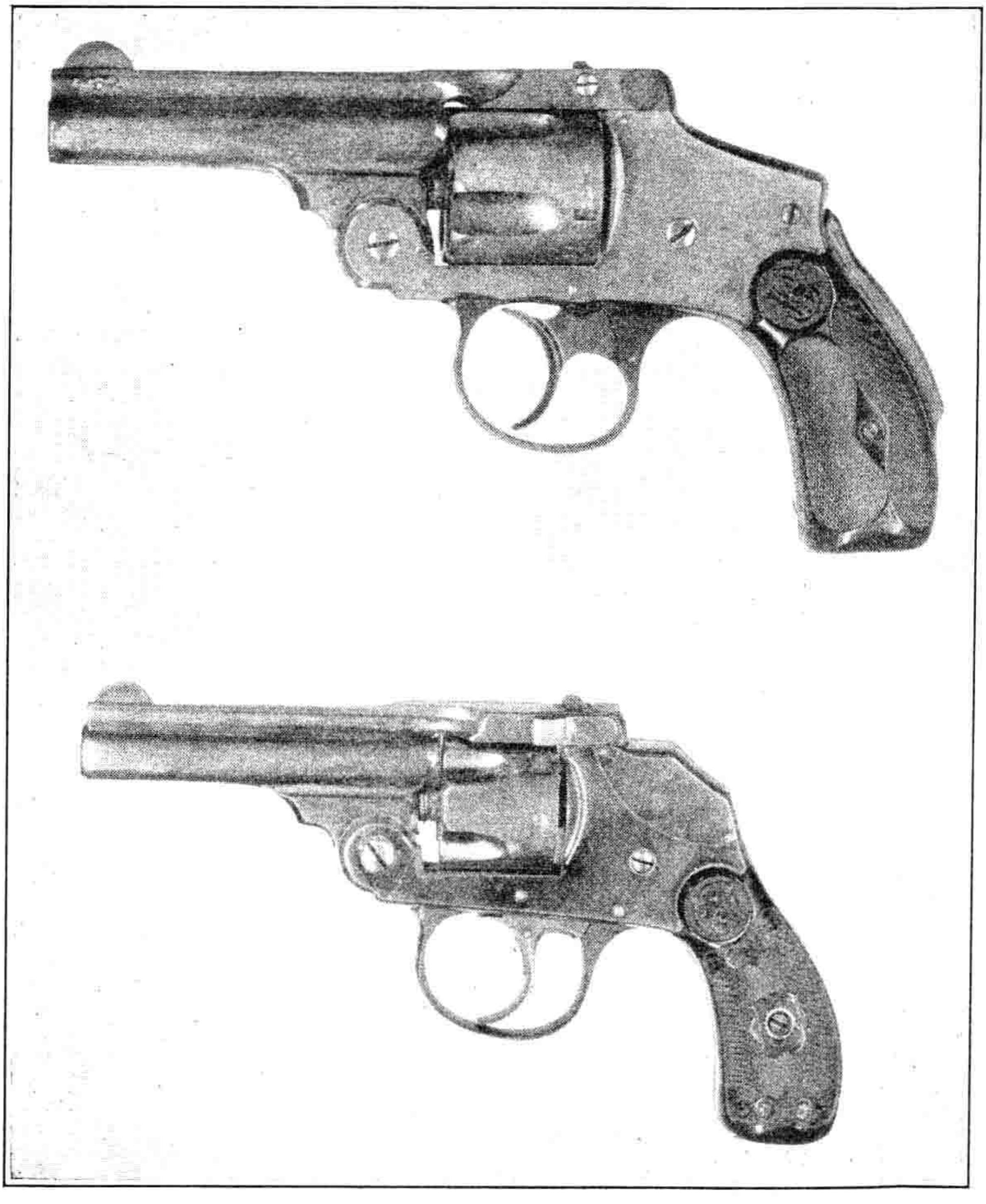
UNDER this heading we include guns for the use of law officers and policemen, bankers, bank messengers, and others; guns for the protection of the home, and all pocket guns.

It is rather difficult to draw any sharp line of distinction between the Military and target arms already described, and home defense guns. For example, any of the fine target arms will serve for home protection, and this protection will be unusually effective, because the owner of a target arm will be familiar with the sport of shooting, and therefore will know how to use the pistol safely and effectively. Then, again, the Military arms will be effective for home defense, banks, etc., and such guns as the S. & W. Military and Police or the Colt Official Police, when furnished with the 4 inch barrel make excellent and most effective pocket arms. These guns, which have already been described under the Military classification in the last chapter, also make the very best holster guns for policemen and law officers. The four inch barrel is the longest that should ever be used as a service arm by law officers. It is long enough to get almost the maximum power and accuracy out of the cartridge, and at the same time it is not so long as to be unhandy. It is a mistake for a police officer to use a gun with a six inch barrel. It adds nothing to the effectiveness, and it makes the gun slower to draw and to use.

With the understanding that many of the guns already described are excellent for the purposes we have in mind, we will now proceed to describe the smaller and shorter revolvers and automatic pistols, that are suitable only for these uses, and not for target or military use.

Smith & Wesson Safety Hammerless

Among the revolvers in the pocket class the place of honor certainly goes to the Smith & Wesson Safety Hammerless. This gun has been on the market for forty-five years and is apparently just as popular today as when it was first introduced and is by no means obsolete. In fact, for the average gun to keep around the house, I can think of no better revolver than this. As its name indicates, it is hammerless and has no projections that can catch on the pocket or in any way cause accidental discharge. It can not be discharged by dropping it or striking it in any way. It has a double action with a rebounding lock, and unless the trigger



Two hammerless pocket revolvers. Upper, the Smith & Wesson Safety Hammerless. Lower, the Iver-Johnson Hammerless. The S. & W. is shown in the .38 caliber, and the Iver-Johnson in the .32, though both makes may be had in either caliber.

is pulled, the hammer, which is fully enclosed, is in the down position and the firing pin does not touch the cartridge. The trigger pull is purposely made long and fairly heavy, with a distinct pause just at the point where the hammer is cocked. This makes the gun very easy to shoot accurately. For quick work you simply point the gun at the object and pull the trigger all the way back, and the gun is fired. For deliberate work you point the gun at the object and draw the trigger back until a sudden decided resistance is encountered. At this point the hammer is fully cocked and then careful aim is taken and a little added pressure placed on the trigger, when the gun is discharged. After a little practice this gun can be fired almost as accurately as if the hammer could be cocked by hand.

This gun also has a grip safety, and this was the first arm on which the grip safety was used. An excellent feature about this arm is that it is physically impossible for a small child to fire it. This is on account of the fact that the hand must not only press the grip safety, but must also draw the fairly heavy trigger through quite a distance, something a child can not do. For a gun to be kept in a desk or bureau drawer around a house, I can think of nothing better. It can be thrown around or dropped on the floor and there is no danger of having it go off, and if small children should accidentally get hold of it they can do no harm. It is made in two calibers, the .32 S. & W. Short, and the .38 S. & W., shooting also the .38 Colt Police Positive. The .32-caliber has a 3-inch barrel and weighs 14¼ ounces. The .38 caliber has a 3¼- or 4-inch barrel and weighs 18¼ ounces. The gun has a tip-up action for loading and ejecting. The cylinder holds 5 shots.

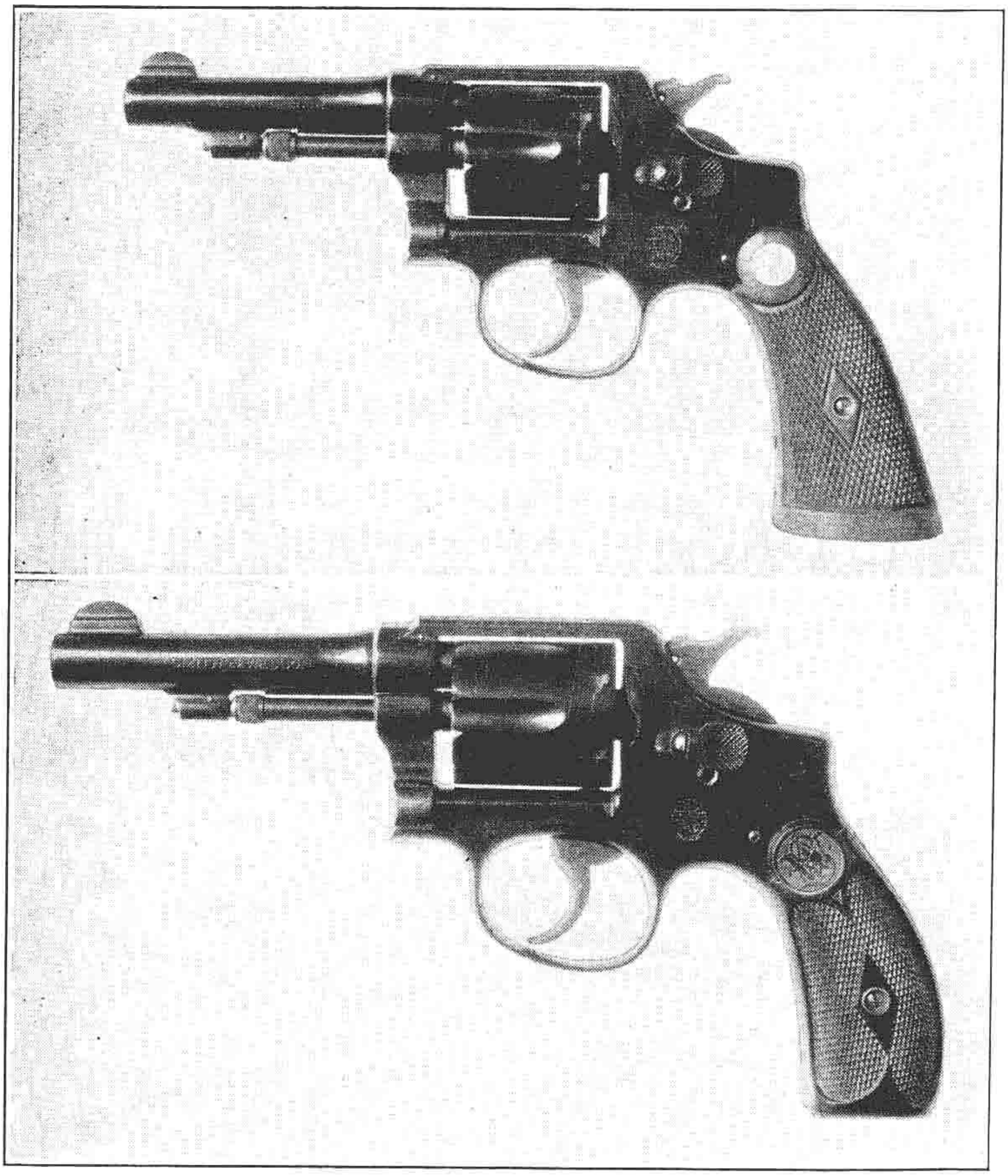
Iver Johnson and Harrington & Richardson Revolvers

Both the Iver Johnson Arms and Cycle Company, and Harrington & Richardson also make .32 caliber and .38 caliber hammerless 5 shot pocket revolvers, and these firms also make hammer guns as well in the .32 and .38 pocket sizes, and the Iver Johnson has the famous "Hammer the Hammer" safety on it, which is, briefly, an arrangement whereby the hammer does not directly strike the cartridge, but strikes on a lever which is placed in front of the firing pin by the act of pulling the trigger. In this way there is no danger of accidental discharge if the gun should be dropped.

Smith & Wesson ".32 Hand Ejector"
Smith & Wesson "Regulation Police"

These guns are the same except for the shape of the butt, which is of the square, or military shape in the "Regulation Police," and the more desirable rounded shape in the ".32 Hand Ejector." They are both small counterparts of the large military revolvers made by this firm. They have the well-known solid frame, with swing-out cylinder, and simultaneous ejection by means of a hand operated ejector rod.

They are designed for the special requirements of policemen and law enforcement officers, and are arms of the highest ac-



Upper: The Smith & Wesson .38 Caliber Regulation Police Revolver. The .32 Regulation Police is identical in appearance.

Lower: The Smith & Wesson Military & Police .38 with 4 inch barrel and round butt. This is a superb high powered pocket revolver. The round butt is preferable in nearly every way to the square style. The saving in bulk is especially noticeable when the gun is worn with a shoulder holster.

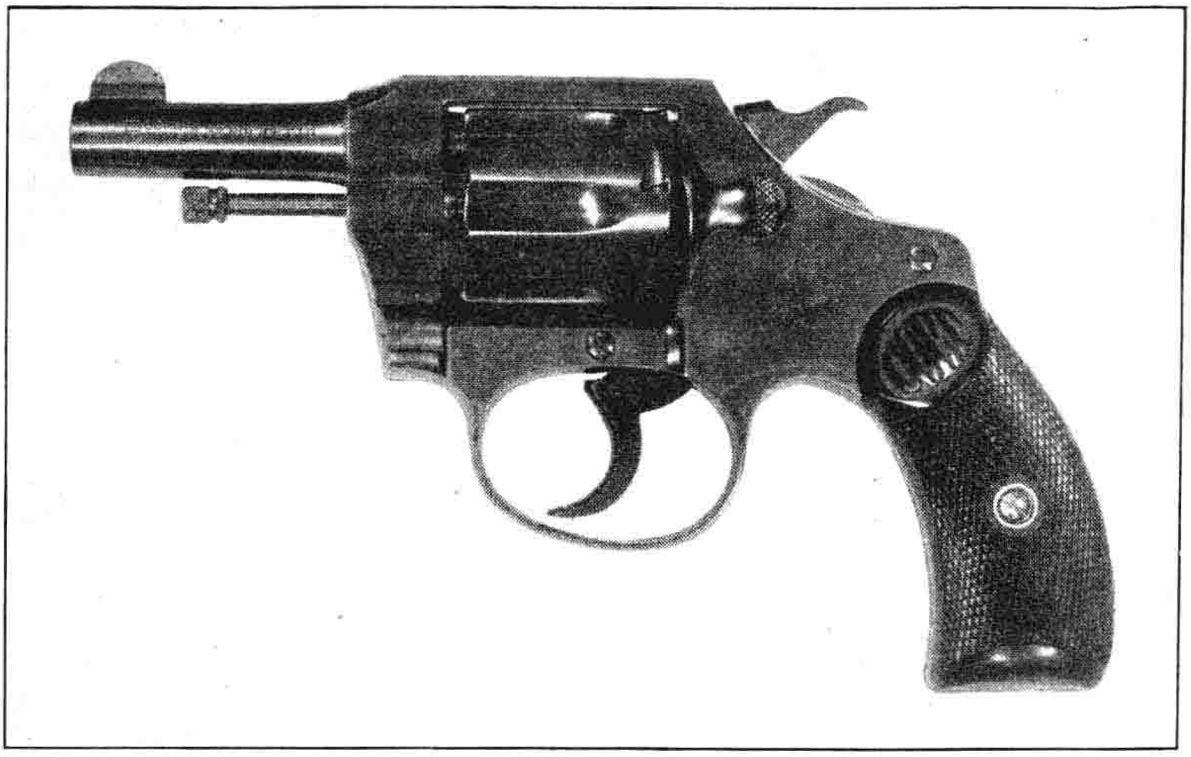
curacy, workmanship, and durability. This model in the .32 S. & W. Long caliber is about the "sweetest shooting" revolver at 50 yards that I have ever handled. The frame and handle of this model is small, the trigger action is light and smooth, and with the .32 caliber, the report and recoil is light. These features combined with the general overall small size and dainty proportions, make this gun perhaps the ideal home defense gun for women who are inclined to be nervous about handling the larger guns. The gun shoots either the .32 S. & W. Short, the .32 S. & W. Long, or the very effective .32 Colt New Police. This latter cartridge has a flat point, which nearly doubles its stopping power, and renders it practically as effective as the round nosed .38 S. & W. Cartridge.

These guns in .32 caliber may be had with 3¼, 4¼, or 6 inch barrel. Weight, with the 3¼ inch barrel, 18 ounces. The short barrel is preferable, unless the arm is to be used especially for target shooting. The round butt is to be preferred to the square or military shape, which has nothing to commend it except appearance, and has the disadvantage of being less convenient, and making the gun more bulky to carry.

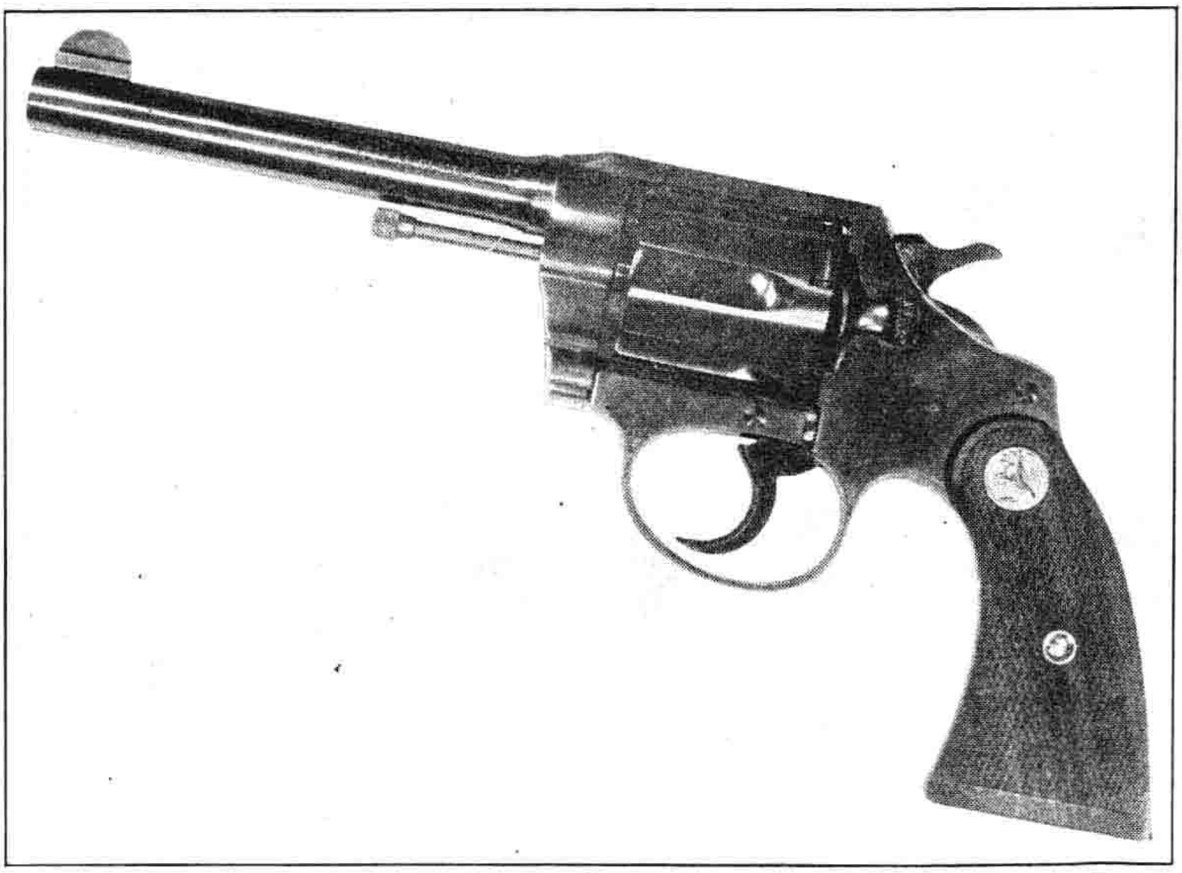
These pocket guns have fixed sights, but the .32 "Regulation Police" may also be had in a target model, with adjustable target sights and a six inch barrel. The "Regulation Police" model is also made in .38 caliber, for the .38 S. & W. or the .38 Colt New Police Cartridges. It has a 4 inch barrel only, and the cylinder holds only 5 cartridges, instead of six, as do the .32 caliber guns of this size. Weight, 18 ounces. This is an excellent gun, which would be better if it had a 3 inch barrel and a round butt.

Colt "Pocket Positive" Revolver

This is a .32 caliber, solid frame, swing-out cylinder, pocket revolver, with a rounded butt to the handle. The name "Pocket Positive" comes from the fact that this revolver embodies the safety device known as the "Colt Positive Lock," which is a sliding piece of metal that lies between the hammer and the frame, thus positively preventing the hammer from striking the primer of the cartridge in case of an accidental blow, or a fall. When the trigger is pulled, this piece of metal is drawn out of the path of the hammer; but should the thumb slip while cocking the gun, the positive lock will return to its position ahead of the hammer and prevent an accident. Only when the trigger is held back during the hammer fall can the cartridge be exploded.



The Colt Pocket Positive Revolver. This is a .32 caliber revolver in which compactness and small size are the outstanding characteristics.



Colt's Police Positive Special Revolver. This is a Police Revolver of medium size, chambered for the powerful .38 Special Cartridge. It has been made as small and compact as a gun can be to handle this cartridge satisfactorily.

Length of barrel, 2½, 3½, or 6 inches. Weight, with 2½ inch barrel, 16 ounces. Caliber, .32, for the Colt New Police Cartridge, though the .32 S. & W. short or the .32 S. & W. long may also be used.

Colt "Police Positive" Revolver

This is a medium powered revolver of light weight and small size, made on military lines, with a solid frame and a swing-out cylinder, in .32 and .38 calibers. As the name would indicate, it embodies the Colt Positive Lock. It is made only with a square butt, which is undesirably bulky and thick at the bottom. Otherwise, this arm is almost ideal for personal or home protection, as well as for police use.

The .32 caliber is made in 2½, 4, 5, or 6 inch barrel, with fixed sights, and cylinder holding six shots. It will shoot the .32 Colt New Police, or the .32 S. & W. Short or Long Cartridges. Weight, with 4 inch barrel, 20 ounces.

The .38 caliber, with fixed sights, is made with 4, 5, or 6 inch barrel, and also, under the name of Banker's Special, with 2 inch barrel. It shoots the .38 Colt New Police or the .38 S. & W. Cartridge. Weight 20 ounces.

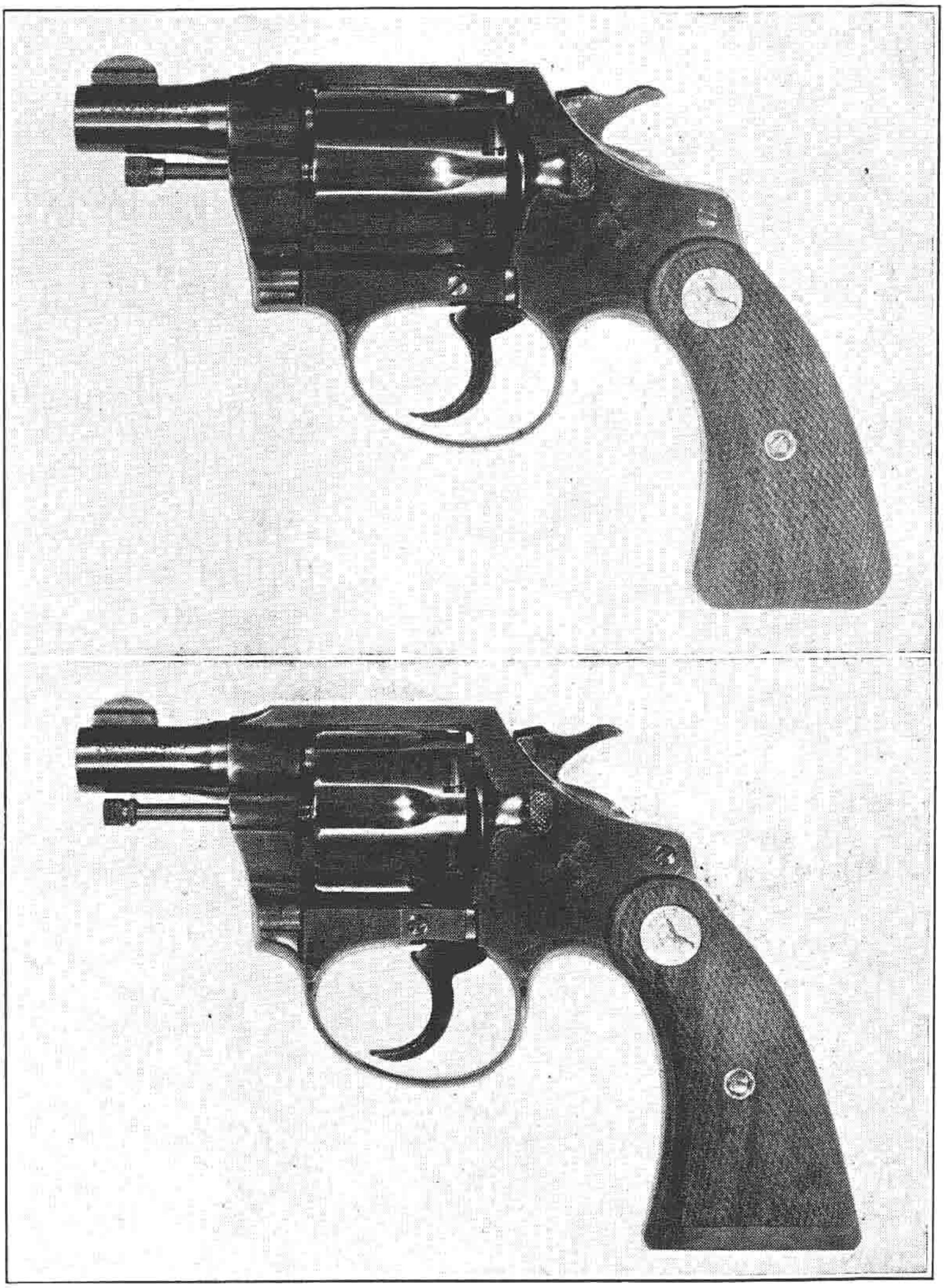
This gun is also made in a target model, already described in Chapter 2. It has a six inch barrel, and adjustable target sights, and can be had in .22 Long Rifle, .22 W. R. F., and .32 calibers.

Colt Banker's Special

This is the "Police Positive" with 2 inch barrel. It is made in .38 Colt New Police and in .22 Long Rifle calibers. The 2 inch barrel is surprisingly accurate, and the short barrel makes this a very compact gun for pocket use. This model is now made with the butt somewhat rounded, which is a decided improvement, as it makes the gun less bulky and less noticeable when carried in the pocket or in the shoulder holster.

This gun in the .38 Caliber is a wonderful gun for bank messengers, express or mail clerks, or others who must have a gun at all times. It was designed especially for the requirements of the railway mail service, and is now the standard gun of that service, many thousand of them having been purchased by the Government for arming the Railway Mail Clerks.

The .22 Caliber model is extremely valuable as a sub-caliber, or practice gun for users of pocket sized .38's. Guns for the protec-



Upper: The Colt Detective Special Revolver, shown with round butt. The square butt can also be furnished if wanted, but is not desirable, as it is more bulky and not so pleasant to handle. This gun is chambered for the powerful .38 Special Cartridge.

Lower: Colt Banker's Special Revolver. This gun, chambered for the .38 Smith & Wesson or .38 Colt New Police, is furnished with either round or square butt at no extra cost. The round butt is much to be preferred, especially on a gun where every effort has been made to attain the maximum of compactness.

tion of valuables may have to be used at night or in other situations where the sights cannot be seen, and the only way to be able to use them effectively is to practice with them enough so that the pointing is instinctive. By the use of the .22 caliber of the same size and shape as the large gun, a sufficient amount of shooting may be done to make the user proficient, without a large expenditure for ammunition. In fact the saving on ammunition will often pay for the purchase of an additional gun in .22 caliber for practice.

The advent on the market of the High Speed .22 caliber Hollow Point Cartridges, and of the High Speed .22 Caliber Sharp Shoulder cartridges gives the user of such a gun as the .22 Banker's Special a .22 caliber cartridge that has quite a respectable shock power of its own, and loaded with these high powered .22's, the Banker's Special may be relied on as an effective home or personal defense gun.

The Colt "Police Positive Special" Revolver

This is a pocket revolver, of approximately the same size as the Police Positive, and weighing but 2 ounces more, but chambered for the powerful .38 Special, or the .32-20 (.32 Winchester) cartridge. It is made as light and small as a revolver can be to handle these heavy cartridges.

It has a solid frame, swing-out cylinder, fixed sights, and the Colt Positive Lock. Length of barrel, 4, 5, or 6 inches. Weight, with 4 inch barrel, 22 ounces. This gun is also made in the .38 Special Caliber, with 2 inch barrel, under the name of "Detective Special."

Harrington & Richardson "New Defender"

This newcomer to the field of pocket revolvers deserves special mention. It is the Harrington & Richardson "Sportsman" double action target revolver with 2 inch barrel, and rounded butt walnut stock.

It has adjustable sights, the front sight being adjustable for elevation, and the rear sight for deflection, the sights are low down on the barrel, so as to be suitable for pocket use, and the front sight is so shaped as not to catch in the clothing, and is fitted with an embedded gold ball sight, which can be quickly seen in all kinds of light.

Like all the recent Harrington and Richardson target arms, this gun has the standard frame, which will take any one of the 5 standard interchangeable stocks. However, the gun comes regularly equipped with the number two stock, shortened and rounded at the butt, and this stock is just right, and is the only one that does feel right.

The surprising thing about this little two-inch barrel gun is the accuracy that it gives on the target. The first time that I shot it my score was 90 on the Standard American Target at 20 yards, and my score, shot at the same time with a single shot target pistol was only 92. I could hardly believe that the little two-inch barrel was capable of such a result, but repeated trials showed that it had really remarkable accuracy. My average score on the Standard American Target at 20 yards over a period of months with this gun was 84.3, the lowest score being 80 and the highest being 94.

The Iver Johnson "Protector" Sealed Eight

Iver Johnson makes a light handy pocket revolver of .22 caliber with a 2½ inch barrel under the name of the "Protector" Sealed Eight. It is similar to the Supershot Sealed Eight except that the barrel is shortened 3½ inches, and the Hi-hold grip is modified somewhat, being smaller and thinner.

This little gun has fixed sights 3½ inches apart, and has the cylinders counterbored to receive the heads of the .22 cartridges, to make it safe for the high velocity ammunition. The author has fired one of these guns with every make of .22 ammunition available, and has not been able to produce a malfunction. It is a fine and handy little gun for those desiring a pocket revolver for the .22 caliber cartridge.

POCKET AUTOMATIC PISTOLS

For home and personal defense, as well as for military use, the automatic pistol has become very much used in late years. The problems involved in making an automatic pistol to shoot a small, low-powered cartridge, such as the .32 automatic, are much less difficult than in the case of high-powered automatics.

Automatics of military caliber must have a locked breech, but in small guns this is not necessary. The breech block is simply held against the base of the cartridge by a heavy spring, and when the gun goes off the bullet has left the barrel before the breech block can move very far. With the large military automatics there are only a few successful systems of locking the breech, therefore there are a limited number of types of these guns. With the small pocket automatic no such mechanism is necessary, therefore there is no limit to the number of different pocket automatics that can be made. All that is necessary is a frame containing a magazine of the ordinary kind and adapted to mount a short barrel, against which a breech block, enclosing the necessary firing pin, is held by means of a spring.

Pocket automatic pistols are made in three principal calibers, and they all use rimless cartridges with jacketed bullets. The calibers are: .25 automatic, which is known in Europe as 6.35 mm.; the .32 automatic, which is known in Europe as the 7.65 mm., and the .380, which is known in Europe as the 9 mm. Short. There is also the .38 automatic Colt cartridge, but there is no European cartridge that exactly corresponds to this, as the 9 mm. Long is not quite the same as the .38 Colt.

Automatic pocket pistols were made in Europe extensively before they were manufactured in this country, and those made there used the 6.35, 7.65, and 9 mm. cartridges. The earliest automatics made in America were the Colts, which were made on Browning's patent, and Browning already had a factory at Liège, Belgium. Therefore, the European models were closely followed in the first automatics made in this country and exactly the same cartridges were used, though they were given American names. For this reason the European automatic pistol cartridges can be used in American automatics with no trouble whatever. The most popular automatic pistols in this country are the Colts.

The Colt .25 Automatic

The smallest of these is the Pocket Model, Caliber .25, Hammerless. It carries 6 shots in the magazine and has a 2-inch barrel. The length over all is only 4½ inches and the weight is 13 ounces. This gun is small enough to be carried in the vest pocket, and that is its greatest recommendation. The cartridge is entirely too small to have stopping power, and while the gun is capable of inflicting a fatal injury, it does not impart enough shock to make a man feel sick as soon as he is hit. It is true that soft-point bullets are furnished for this gun, but this means nothing, as the bullet does not have enough speed to mushroom, and a soft-point bullet does no more harm than a jacketed one.

The gun has a distinct field, however, in spite of its lack of stopping power and the fact that it can only be moderately accurate on account of its short sight radius and short barrel. This field is in its enabling one to have a weapon under circumstances where a weapon could not otherwise be had. This gun is so small and light and insignificant that it can be carried without inconvenience or without any suspicion, and no one wants to be shot even with a .25. Therefore, this gun would often be just as effective as a larger caliber, because in many cases the purpose is served if a would-be assailant simply knows that you are armed.

These little guns have a grip safety and also a thumb safety. The models after No. 141000 are provided with a magazine safety, so that when the magazine is taken out the gun can not be fired, which is an excellent thing indeed because it prevents accidents due to inexperienced persons who forget that another cartridge is in the gun when the magazine has been removed. An exact duplicate of this gun is made under the Browning patents by Fabrique Nationale d' Armes de Guerre, or "FN."

The Colt .32 and .380

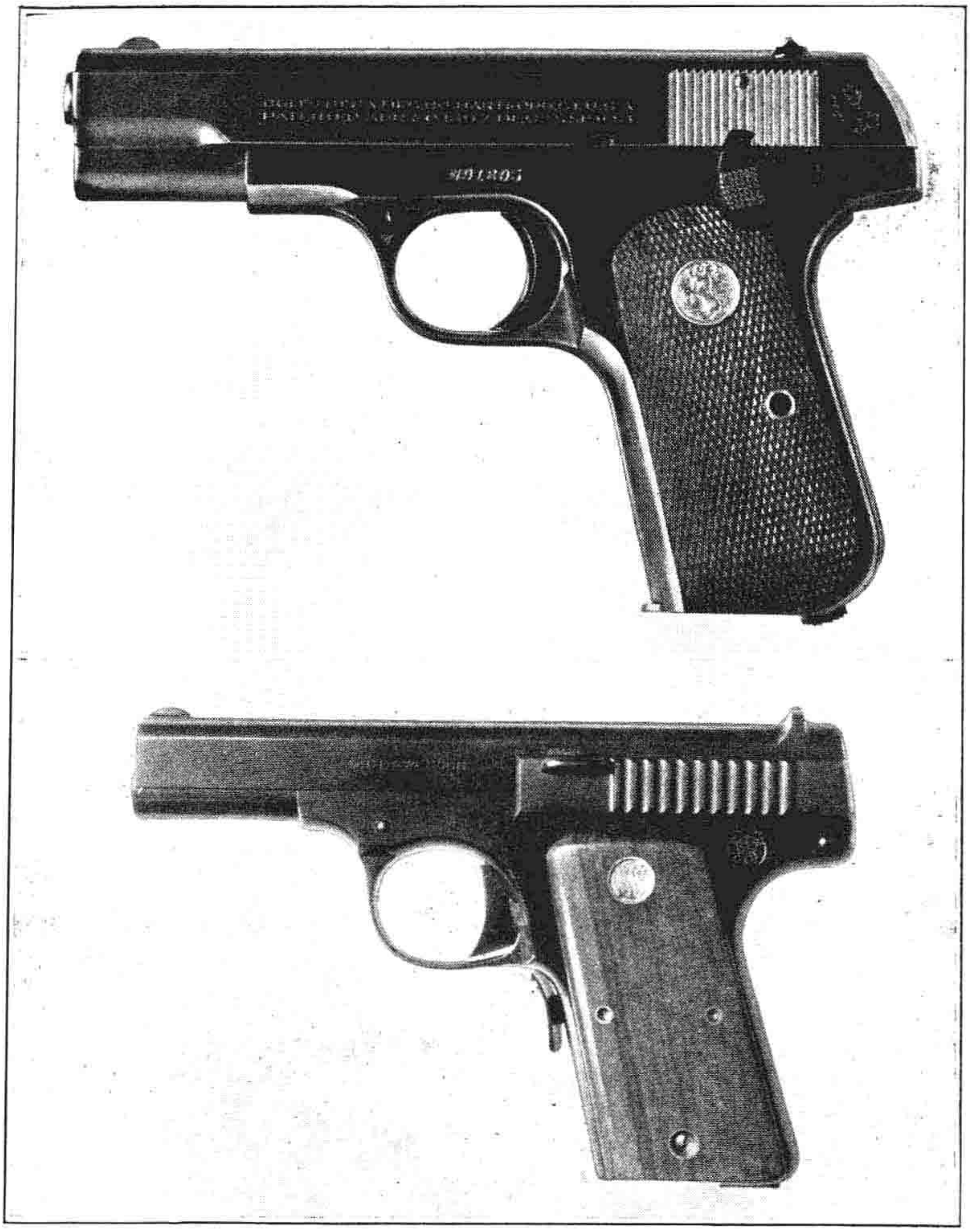
Perhaps the most popular automatic pistol in this country is the Colt Pocket Model Hammerless, which is made in .32 and .380 calibers. This gun is built on Browning patents and, as its name indicates, is hammerless. It is fitted with both grip and thumb safeties. It carries 8 shots in the magazine in the .32-caliber and 7 shots in the .380 caliber.

This gun as now manufactured (the Caliber .32 from No. 468097 and the Caliber .380 from No. 92894) is equipped with a Safety Disconnector similar to that incorporated in the Caliber .25 as described under that model. Previous models do not contain the automatic magazine safety. An extreme source of danger with guns not so equipped is the fact that a cartridge remains in the chamber after the magazine has been removed and the gun is supposedly unloaded. One of the French catalogues that I have very aptly describes this remaining cartridge as "le malhereux dernier cartouche," or, "the unhappy last cartridge."

The Colt automatic pistol is powerful, accurate and very reliable in action. It has a 3¾-inch barrel and weighs 23 ounces. The .380-caliber is recommended as having the most stopping power.

The Smith & Wesson Automatic

Smith & Wesson have also for years manufactured a pocket automatic pistol. For a long time this was made in the so-called .35-caliber. It used a special cartridge designed by Smith & Wesson, which was supposed to represent quite an advance in automatic cartridge design. In this cartridge the front end of the bullet was jacketed in order to work through the magazine and mechanism without scarring up, while the back end of the bullet, which was inside the cartridge case, was somewhat larger in diameter and not jacketed. The idea of the manufacturer was that it was desirable to have the back part of the bullet made of soft metal, so that it could take the rifling better. While this was a very desirable cartridge, it was different from the ordinary .32 pistol cartridge, and for that reason it never did have much commercial success. People did not want to buy a gun and then later find that



Upper: The Colt Automatic Pistol Pocket Model, Caliber .32 or .380.
Lower: The Smith & Wesson Automatic Pistol. A notable feature of this gun is the ease of loading the first shot, as the breech block can be disconnected from the return spring by pushing in a catch before drawing back the breech block to load.

in some out-of-the-way part of the country perhaps they could not get the ammunition. Moreover, this so-called .35-caliber was not really .35 in diameter, but was simply named that to distinguish it from the regular .32. It was really the same diameter as the regular .32 Automatic pistol cartridge. The Company finally discontinued making the gun for this special .35 Caliber Cartridge, and now make it for the regular .32 A. C. P. (Automatic Colt Pistol) Cartridge.

It is a Hammerless pocket automatic with a magazine holding 7 shots. It has a grip safety located on the front of the grip, under the trigger guard. This gun has a feature which makes it easier to load than the usual automatic. This is an arrangement by means of which the action spring is disconnected from the slide during the operation of loading. Instead of pulling the slide back against the strong recoil spring, and then letting it slam forward, this gun is loaded by pressing in a catch on the left side, which holds the spring out of operation. The slide is then drawn back and pushed forward, placing a cartridge in the chamber, and in letting go of the slide, the catch is released, so that the spring holds the slide shut, ready for firing. This feature was placed on the gun to render easier its operation by women and others not having great strength.

The gun has a 3½ inch barrel and weighs 35 ounces.

The Savage Automatic Pistol

Though this gun is no longer manufactured, a description is included, as many thousand of these guns are still being used all over the world.

The Savage Arms Company made a pocket automatic pistol in .32 and .380 calibers which has a number of unique features. In the first place, this gun has a locking action for the barrel, something which is not common in the pocket automatics. In the second place, it has an extra large magazine capacity. The magazine of the .32 holds 10 cartridges and the .380 holds 9. About 1911 this gun was highly advertised in the magazines under the slogan of "Ten Shots—Quick!" The gun was invented by Major Searles, who formerly worked at Springfield Armory and was a major in the Ordnance Department during the World War. In 1917 the outward appearance of this pistol was changed somewhat by giving a greater slope to the back of the grip, so as to aid in natural pointing, and by putting a spur on the cocking lever or semi-hammer that was used on the earlier models.

The main feature of the mechanism is that when the breech block moves backward the barrel has to turn, and while the bullet is going through the barrel the work of spinning the bullet resists this rotation of the barrel; therefore, it helps to hold the breech locked. Another feature of the gun is the ease with which it can be completely dismounted for cleaning. The barrel comes out and is entirely separated from the rest of the mechanism without the aid of tools in just a few seconds. While this gun is what might be called a semi-hammerless, it has a thumb safety, and while this safety is on it positively holds the hammer back so that the arm can not be discharged even though the sear may be jarred off.

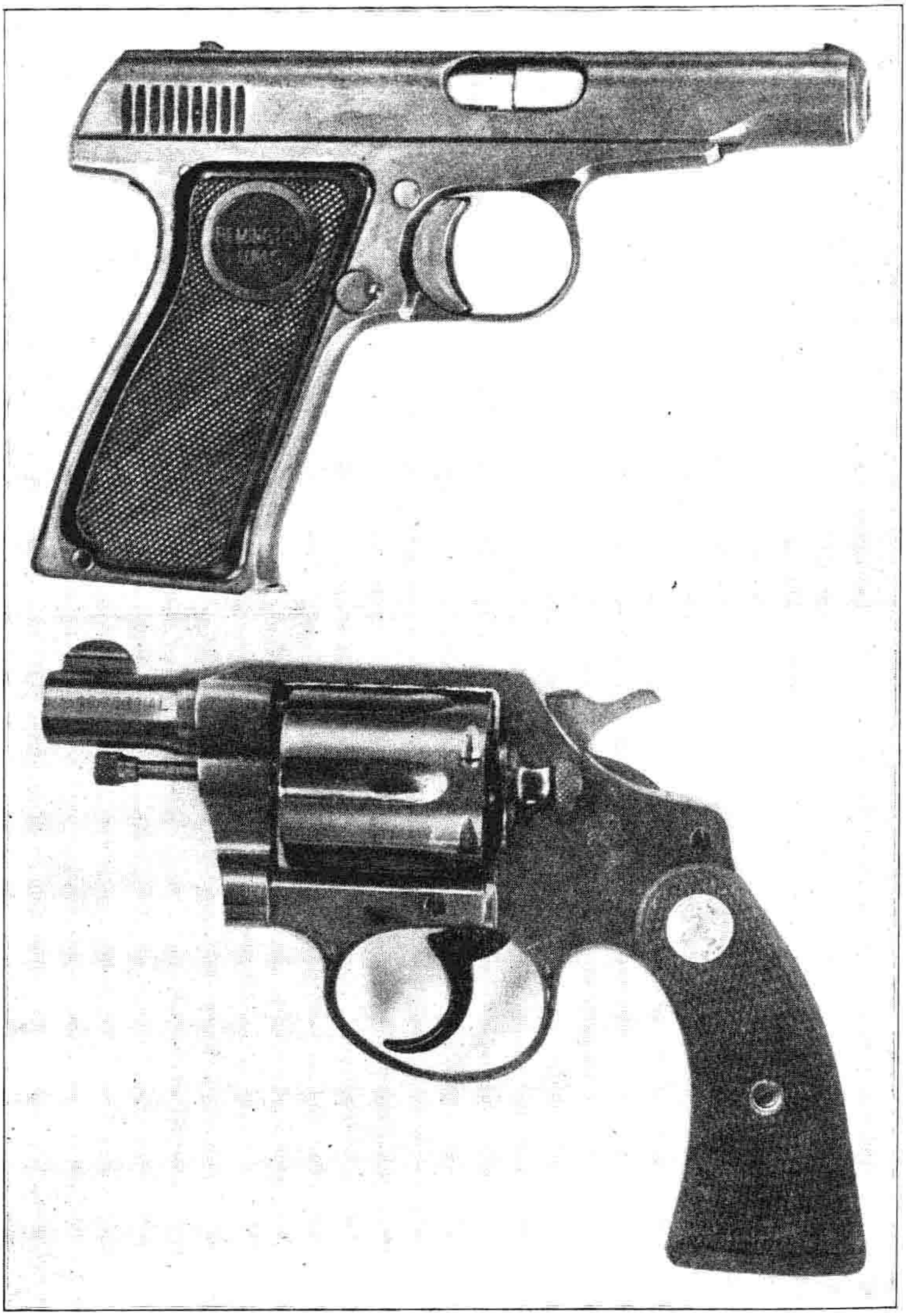
To clean the barrel, remove magazine, draw back bolt, and raise safety to hold it back. Insert brush or cloth saturated with good light oil, preferably a nitro-solvent, at muzzle, clean inside of barrel thoroughly, and leave a thin film of oil in the barrel afterwards. Then throw down safety, letting bolt snap forward, and insert magazine. Never use heavy oil or grease on the pistol. Occasionally dismount pistol enough to wipe off breech plug, sear-trip mechanism and inside of frame and bolt with an oily cloth.

The Remington Model 51 Automatic Pistol

Like the Savage, described above, this gun is no longer manufactured, which is to be regretted, as it had many extremely desirable features. It was invented by J. D. Pedersen, one of the greatest living designers of firearms in the world. He is also the inventor of the Remington pump action shotguns, the Remington trombone action rifles, the Semi-Automatic Military rifle made by Vickers, Ltd., and many other famous arms.

The Remington Automatic Pistol is a hammerless, locked breech, pocket automatic pistol, made in .32 and .380 calibers. The breech locking mechanism is very clever and ingenious.

The arm has a grip safety which also serves as an indicator to tell when the gun is cocked. When the hammer is snapped the grip safety stays in. The thumb safety also acts as an indicator because it can not be put in a safe position when the hammer is down. There is also a magazine safety, so that the gun can not be fired when the magazine is out of the gun. The magazine holds 7 shots. The length of the barrel is 3¼ inches. The weight of the gun unloaded is 21 ounces. In designing this gun the inventor gave the greatest care and attention to the features of balance, angle, and shape of the grip and sights. In designing the grip a



Upper: The Remington Model 51 Automatic Pistol. This excellent arm was formerly made in both .32 and .380 calibers, but has now been discontinued.

Lower: The .38 Colt Detective Special Revolver. This is really the Police Positive Special with a 2 inch barrel.

frame representing the necessary shape of the magazine was covered with modeling clay until it was just right for the hands of various different-sized men and women. A number of these models were made, and finally all these models were compared and a grip was made up which was a compromise, so that it would best fit the average hand. The result is a grip that is more comfortable than that of any other automatic pistol that I know of. In addition, the curve at the back of the frame and the hole in the trigger guard were so located in relation to each other that the barrel lies in an exact parallel line with the index finger. The top of the slide was made flat and matted to avoid the reflection of light. The sights are low and close to the top of the slide, so that they will not catch in the pocket or clothing and are square, or Patridge, shape which is best adapted to accurate quick shooting.

Webley Automatic Pistols

Messrs. Webley & Scott, of Birmingham, manufacture pocket type automatic pistols in four calibers, namely, the 9 m/m Browning long, the .380 Automatic, the .32 Automatic, and the .25 Automatic. The name of the maker is a sufficient guarantee of workmanship and high quality material.

The "M.P." or Metropolitan Police Model

This is a pocket model automatic with an outside hammer. Capacity of magazine, 8 shots for the .32, and 7 shots for the .380. Weight, with magazine, .32 Caliber, 20 ounces.

This gun has been adopted by the London Metropolitan police force, as well as by the police forces of Cairo, Adelaide, and many other cities.

The ballistics are in every way similar to those of the corresponding Colt models.

Webley New Military & Police Automatic

This powerful pocket or holster automatic is chambered for the 9 m/m Browning Long cartridge, which is considerably more powerful than the 9 m/m short, known in this country as the .380. This pistol gives a muzzle velocity of about 1000 feet per second. Like the "M. P." model, it has an outside hammer. Weight of the gun with magazine empty, 32 ounces.

Webley .25 Caliber Automatic

This small pocket automatic is similar in size to the .25 Cal. Colt Automatic, and uses the same cartridge. It is made in two styles, one being hammerless, and the other having an outside hammer. The magazine holds six shots, and the gun, with magazine empty, weighs 12 ounces, (Hammer model.)

Walther Police Pistols, Models P.P. and P.P.K.

These German pocket automatics have a number of exclusive and unique features that demand special notice. They have an outside hammer, and a thumb safety, and if the safety is in the "Secure" position, indicated by a red circle, the pistol can be loaded, by drawing back and releasing the slide, without cocking the hammer. In this state, the pistol is loaded, yet is safe from accidental discharge, as the hammer is not cocked; yet the pistol can be discharged from this position with one hand by placing the safety lever in the "Ready" position, and then simply pulling the trigger; for the trigger has a double action arrangement by which the hammer is cocked and then discharged by a single pull. After the first shot, the gun cocks itself as usual, but in case of misfire, a second blow can be struck merely by pulling the trigger. When the safety is on, the hammer cannot strike the cartridge, even if the gun should be dropped.

There is an indicator pin that protrudes above the hammer whenever there is a cartridge in the chamber. This is furnished only on the center fire models, however, and not in the .22 rim fire.

There are two sizes, the P.P. (Polizei Pistole) and the short, or *kurz* model, P.P.K., which is three-quarters of an inch shorter.

These guns are made not only in the usual 7.65 m/m (.32 A.C.P.) and 9 m/m (.380 A.C.P.) calibers, but also in the .22 Long Rifle Rim Fire Caliber as well.

Dimensions of the .32 caliber are as follows:

	P.P	*P.P.K.*
Over all length	6 5/16 inches	5 7/8 inches
Barrel length	3 7/8 inches	3 1/4 inches
Height	4 1/4 inches	4 inches
Thickness	7/8 inch	7/8 inch
Weight	1 lb., 7 oz.	1 lb., 3 oz.
Magazine capacity	8 shots	7 shots
Muzzle velocity	954 f.s.	924 f.s.

The Walther firm, of Zella-Mehlis, Germany, also make a 6.35 m/m (.25 A.C.P.) pocket automatic, and a .22 caliber rim fire target automatic.

Mauser Pocket Automatics

These guns, made by the famous firm of Waffenfabrik Mauser, of Oberndorf a/n ("On the Neckar") Germany, had attained a considerable degree of popularity in America before the World

War, and are now sold by the firm of A. F. Stoeger, Inc., New York, the sole importers.

They are made in two calibers, for the popular American .25 A.C.P. and .32 A.C.P. cartridges, known in Germany as the 6.35 m/m and the 7.65 m/m respectively. The two guns are alike in design. When the last shot has been fired, the slide remains open, and can be closed only by the insertion of a magazine, which causes the slide to close automatically, placing a cartridge in the chamber at the same time, in case the magazine be loaded. There is an indicator pin which protrudes from the breech whenever the mechanism is cocked.

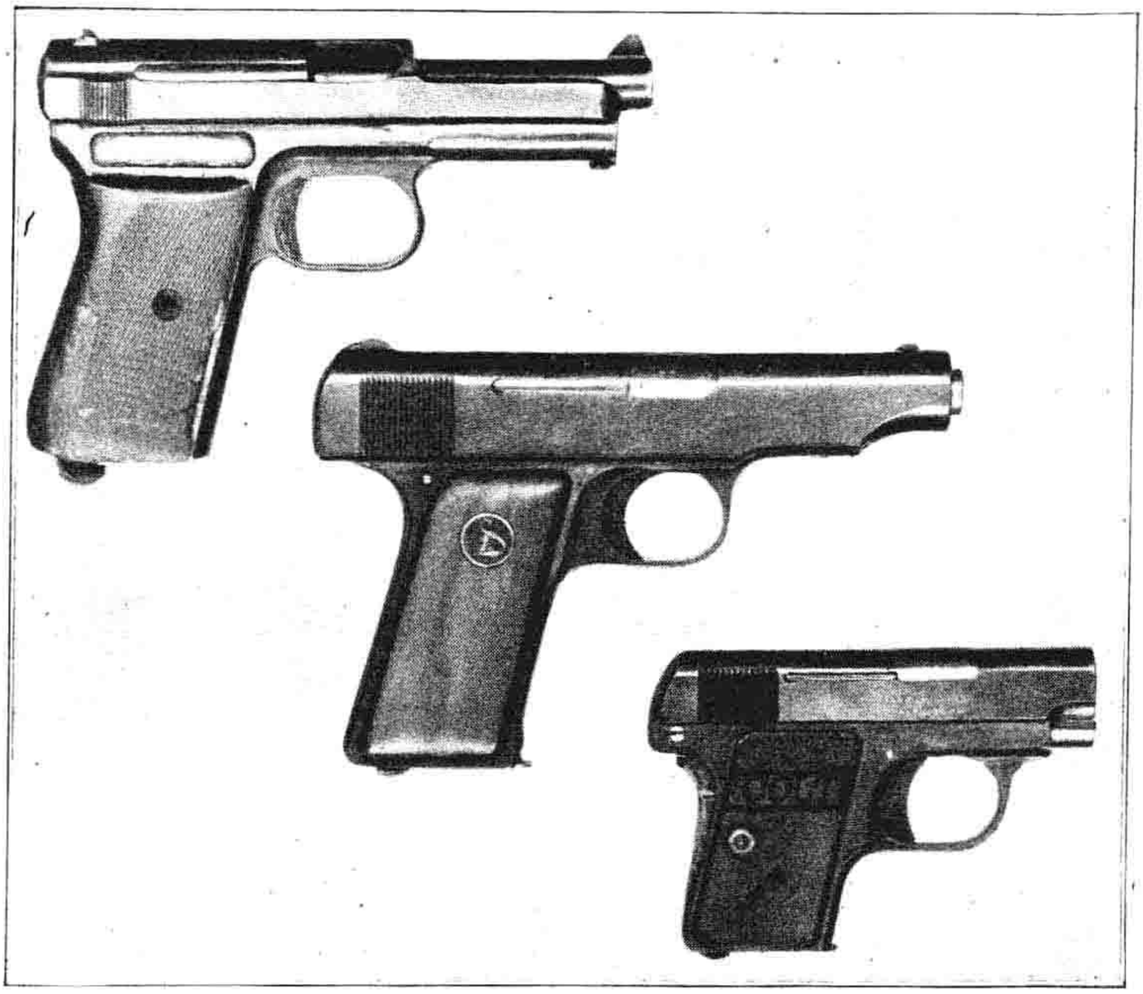
There is a magazine safety, which prevents the firing pin from being released unless the magazine is in place. This prevents accidents resulting from the assumption that the gun has been unloaded by the removal of the magazine, while the cartridge in the chamber still remains. There is a thumb safety on the left side, near the trigger guard. Pressing this safety down makes the gun safe, and locks it so, as the safety cannot be pushed up again. The gun is made ready by pushing in a button located just under the safety, which releases the safety, and allows it to snap up to the ready position under the action of a spring.

The .25 Caliber model is considerably larger than the .25 Colt, and on account of the longer barrel, it is easy to shoot accurately.

The Mauser firm also make a vest pocket .25 Automatic, much like the Colt in appearance and size.

The Ortgies Automatics

Another pocket automatic pistol of German make that has been sold in this country in considerable quantities is the Ortgies, made in 6.35 and 7.65 caliber. An interesting thing about this gun is the fact that the safety is rather unique. It consists of a grip safety which, however, does not become operative unless a small button on the left hand side of the grip is pressed, when the grip safety springs out into position. Another interesting thing about this gun is the fact that it is very difficult to dismount without first being shown how, because, look all over the gun as you may, there is nothing apparent to show how it can be taken apart, and I have known some people to spend quite a time trying to find out how to get this gun taken down. It is really simplicity itself when you know how. Grasp the slide with the left hand and the handle with the right hand, pressing on the safety release button with the thumb. Push the slide back about a half inch and lift upward, when it will come loose from the frame and the whole gun can be taken apart. However, once you have it apart it is almost impossible to put it together unless you know the trick of doing it, which is to lock the firing-pin spring out of action for the purpose of assembling. To do this, look in the top of the slide and inside you will see a small semicircular cut. By pushing the firing-pin spring in, the little stem which goes in the back end of the spring can be pushed down into this cut to lock the spring into place; then the slide can be assembled by reversing the operation of taking it off. If the spring is not locked in position as described, it is impossible to get the slide back on because the spring projects out the rear end.



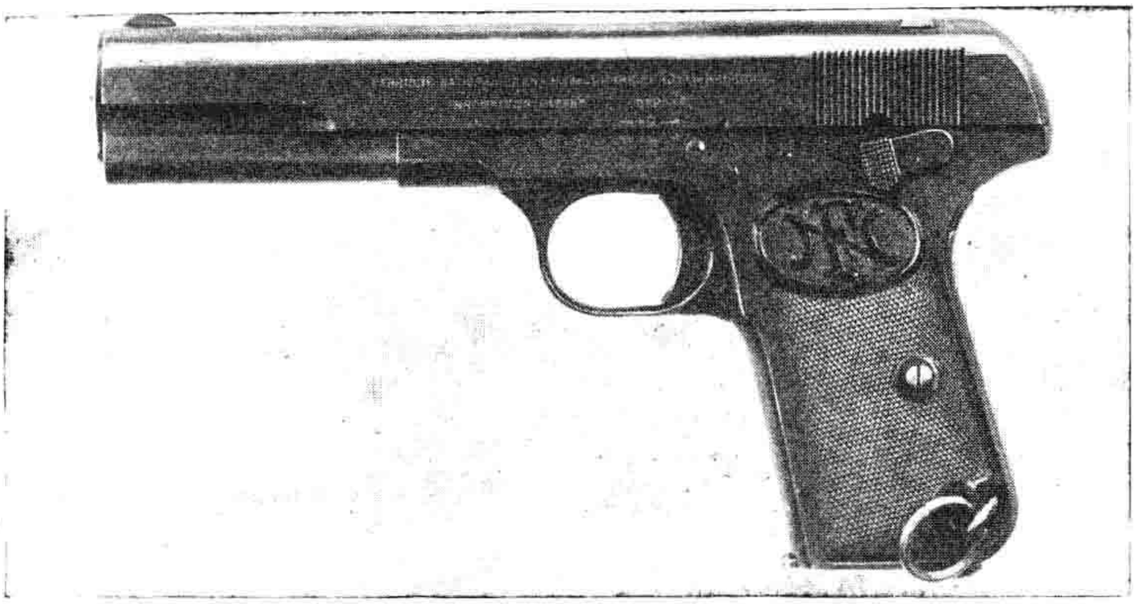
Three pocket automatics often seen in this country. Top: The Mauser Pistol, caliber 7.65 mm., using the .32 A. C. P. cartridge. It is also made in 6.35 mm. (.25 A. C. P.) Caliber. Middle: Ortgies Automatic Pistol, 7.65 mm. Lower: Colt .25 Vest Pocket Model.

There is one precaution to be followed in regard to assembling, however, and that is to remember that in putting back the slide you may disengage this spring from the little cut. In fact, this is quite likely to occur, and when it does the spring and the little rod on the end of it shoot out with violence, and if it is pointed toward your face it might put an eye out, so always hold it so if this comes out it will not do any harm and will not get lost.

Another tricky thing about this gun is the way in which the grips come off. There are no screws visible on the outside of the gun anywhere. To remove the grips, take out the magazine and with the end of a lead pencil press on the back of the frame inside the magazine space about half way up, when the grips will fall off, as they are held in place by a spring catch.

Belgian Automatics

Belgium is quite a center for the manufacture of firearms, and one of the most prominent of the Belgian factories is the Fabrique Nationale d'Armes de Guerre, located at Herstal near Liège. It is this factory that makes the Browning pistols in Europe. The Colt Patent Fire Arms Company is licensed under the same patents to make automatic pistols in America, and under the patent agreement the Brownings are not allowed to be sold in this country, nor the Colts in Europe. For that reason the Browning automatic pistols are rarely seen here. These pistols are the invention of the late John M. Browning, of Ogden, Utah, who died in December, 1926.



The 9 m/m Browning as it is manufactured in Belgium.

Several years ago the millionth Browning pistol was manufactured at the Liège factory.

It was a Browning automatic pistol that fired the fatal shot at Sarejevo which assassinated the Archduke Francis Ferdinand, thus starting the World War.

The Browning factory makes pistols in the 6.35, 7.65 and 9 mm. short calibers. In fact, most of the automatic cartridges that you find are marked "For Browning or Dreyse."

The smallest of this line is the "Baby Hammerless," of which the .25 Colt is almost an exact duplicate. The 7.65 is very similar to the .32 Colt. The 9 mm. Browning pistol illustrated is marked on the left side, "Fabrique Nationale d'Armes de Guerre Herstal-Belgique, Brownings Patent Deposé." On the side of the barrel and frame it has three proof marks—an "E" with a star over it; a Lion over the letters "P.V.," which is the Belgian nitro-powder proof, and the little Belgian tower proof mark. On the barrel it also has the Crown over the letter "R," which is a proof mark for rifles, pistols and revolvers, and also the "ELG" in the oval with a crown on top.

In this gun the slide stays back on the last shot and is released by pulling back and letting go. To dismount, hook back the slide with the safety, turn the barrel one-quarter turn, release the safety and pull the barrel and slide forward.

The Bayard

Another well-known Belgian automatic is the Bayard. This arm is noted for its extreme compactness. It is made in 7.65 and 9 mm. calibers, and the barrel is bored in the front part of the frame just forward of the trigger guard. The Bayard is made by Anciens Etablissements Pieper, formerly the firm of H. Pieper.

The Clement

Another Belgian gun is the Clement, made in 6.35 and 7.65 caliber by Charles P. Clement of Liège. These pistols can be almost instantly opened for cleaning by pressing down on the trigger guard and tilting up the barrel.

The Pieper

The Pieper is made in 7.65 and 6.35 calibers by Nicolas Pieper of Liège. Some confusion is sometimes caused by the fact that the Bayard is also made by a Pieper firm in Liège, but it is a different company, as mentioned.

French Automatics

An interesting line of automatic pistols is made by the manufactory Francaise d'Armes et Cycles de Saint Etienne. One of the features of these automatics is that the lock mechanism is double action, not automatic. In other words, pulling the trigger cocks the hammer and then snaps it, the same as in the Smith & Wesson Safety Hammerless. This makes very greatly for safety because you do not have an automatic pistol with a cartridge in the chamber and the hammer cocked at all times, but at the same time you have an automatic that can be instantly fired merely by pulling strongly enough on the trigger. These little guns also have a magazine safety so they can not be fired when the magazine is out, and moreover, they are very easy to clean because the barrel tips up, by pressing a catch, so that the breech is fully exposed. They are made in 6.35 and 7.65 calibers.

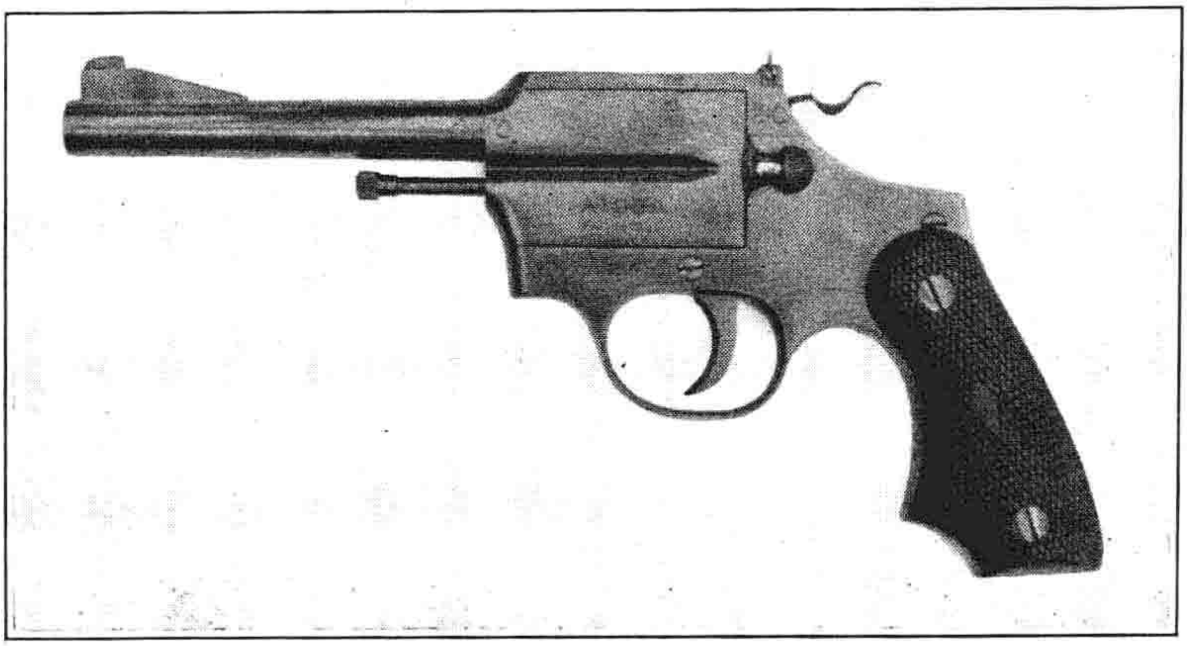
Spanish Pistols and Revolvers

One of the two great European centers for the manufacture of inexpensive firearms is Belgium. The other is Spain. In both these countries there are cities where there are hundreds of small shops which either make complete firearms of nondescript patterns, or else make parts on a contract system for some larger establishment which does the assembling and marketing. Much of the work is largely done by hand, in the cheapest possible way. In Belgium, for example, there are many muzzle loading "trade guns" made in this way, intended for sale in Africa and other out of the way places where anything that looks like a gun will be welcomed by certain classes of natives. Perhaps the principal center of this type of manufacture in Belgium is Liège, while in Spain it is Eibar.

Spanish arms in general have obtained a bad reputation in America because just after the World War the American market was flooded with cheap and crudely made revolvers and automatic pistols of Spanish origin, which could be bought for ridiculously low prices, and many of these pot-metal weapons were almost exact copies of the more popular Colt and Smith & Wesson models. The unsuspecting buyer would see what was apparently a Smith & Wesson .38 Military & Police Revolver, for example, in a store window, and on the side of the barrel he would see, in big letters the name SMITH & WESSON. But if he purchased the gun, he would find that the workmanship and material was of the crudest, and if he looked more closely at the name, he would see that it read "for SMITH & WESSON ctg.," and that the name of the real maker was absent. Tucked away in some inconspicuous place he might find the word "Spain," or the statement, "Made in Spain."

The unfortunate situation that has been described above, which allows exact imitations of the American guns to be made as described, is due to certain complicated ramifications of the Patent and Trade-Mark laws in the two countries, with particular reference to the lack of reciprocal trade agreements, etc.

The Spanish authorities grant patents of which the duration depends largely on whether or not the article in question is manufactured in Spain. One pays an initial fee of moderate amount, and thereafter, for three years, a small annual fee, provided that the patented article is not manufactured in Spain during that time. If manufacture is started during the three-year period, the annual fee ceases, and no more fees have to be paid as long as the manufacture continues; but if the three years are allowed to pass without any manufacture of the article in Spain, the patent lapses, and becomes public property. Several years ago the matter of a reciprocal agreement covering some of the points involved was taken up by the authorities of the two countries, and there was a lot of talking, but nothing was done, as the spokesmen for the United States were handicapped by a number of laws, customs, rules, etc., which affected the Spanish interests adversely, such as an American embargo on the importation of malaga grapes, the immigration laws, prohibition, etc., concerning which the United States either could not, or would not make any concessions.



The "ATCSA" single shot target pistol, caliber 4 mm. To reload, the barrel swings on vertical pivots at the front end of the frame. The rear sight is adjustable for both elevation and windage.

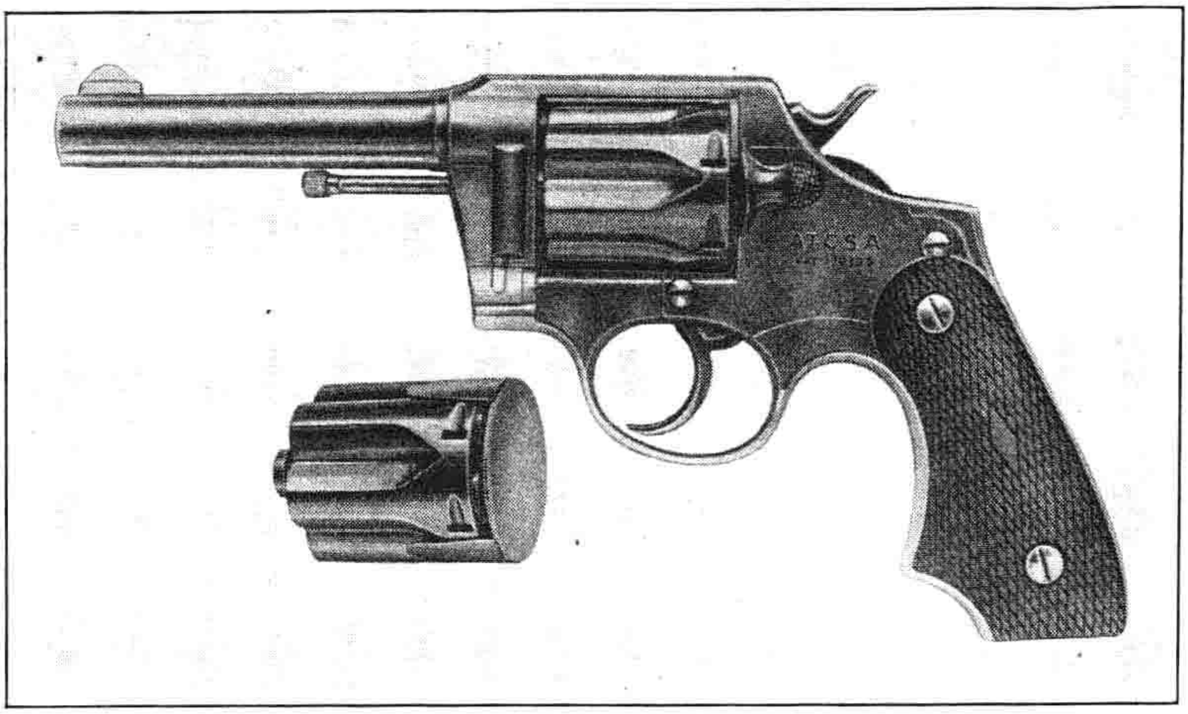
However, there are reputable firms in Spain which do make arms of good quality and workmanship though these better examples of the Spanish gun making industry are not so often seen in America. Naturally the situation which we have described above has been distasteful to the better Spanish firms and to the authorities and effective steps have been taken to improve the general quality of Spanish arms so that it can confidently be said that the Spanish manufacture of pistols and revolvers has improved notably during the past ten years, and the improvement has been progressive. Much better steel is now used and one firm (ATCSA) even go so far as to make the cylinders of their revolvers of Poldi Anti-corro steel, though the manufacturers of Eibar do not, it is generally admitted among Spanish shooters, use as good steel as do Smith & Wesson and Colt; but the steel of the best Eibar manufacturers is considered very nearly as good and their arms are rugged and beautifully finished.

The number of Spanish makes has diminished with the improvement in quality and the innumerable firms which formerly turned out poor material have for the most part been driven from the market. Fifteen years ago one could buy a new so-called revolver in Spain for about $2.50; but it is hard to find such guns at the present time and the reputable arms made in Eibar cost about the equivalent of $15.00 at that place.

Revolvers

Perhaps the most popular revolver now made in Spain is called "El Tanque" and is manufactured at Eibar. The target model of this gun, with adjustable sights and a six inch barrel is chambered for the .38 special cartridge and combines features of both the Colt and Smith & Wesson revolvers. This gun is a very handsome weapon and of late years has won many matches in Spain where top notch shooters were competing. The Colt or Smith & Wesson revolvers still are considered in Spain as the most desirable target revolvers but by the time importation charges and customs duties are paid, they cost the Spanish buyer perhaps five times as much as El Tanque. One of my acquaintances who lives in Spain reports that he has seen charges of smokeless powder that can only be described as barbarous used in the Tanque by reckless hand loaders and he has never known one of these guns to burst.

Another Spanish make which deserves special mention is ATCSA of Barcelona. The name comes from the initials of the firm Armas de Tiro y Caza, S. A. These guns are of recent design and manufacture and cost in the neighborhood of $20.00 in Spain. They are notable for the fact that they use only the best material obtainable. A feature of their revolvers is the fact that, though they have a solid frame and a swing out cylinder, there is a latch on the front of the crane by which the cylinder can quickly be removed. This feature is made use of to allow the gun to be quickly reloaded, as an extra cylinder already charged can be carried in the pocket. A quickly detachable spring steel cap fits over the heads of the cartridges in the additional cylinder and holds the cartridges in place until the cylinder is inserted in the revolver.



The "ATCSA" .38 Special Revolver, made in Barcelona. Note that the gun is fitted with interchangeable cylinders for speed in reloading. Note also that the extra cylinder has a spring-steel cover for holding the cartridges in the extra cylinder, and for protecting the primers.

This firm also makes a single shot pistol in which the barrel swings to one side on a vertical pivot for reloading. I have done a considerable amount of shooting with one of these gun in the 4 mm. caliber and find it to be highly accurate at short ranges.

This firm has thus far confined its sales efforts to the police and military authorities with whom they have had a considerable degree of success.

Other Spanish revolvers are the "Destroyer" which is made in a target model with six inch barrel chambered for the .38 special. As far as I know it has not won any big matches but it seems to be a glutton for punishment when it comes to withstanding heavy charges.

Other good revolvers are the Gaztañaga y Trocaola (made by the firm of this name in Eibar) and the "Alfa," made by a workers' guild in Eibar. They are made for the .22 long rifle, the .32 Smith & Wesson and the .38 Special, which is the most popular revolver cartridge in Spain.

Automatic Pistols

The improvements in automatics in Spain has been quite as marked as it has in regard to revolvers. The most popular cartridges are the 9 mm. Bergmann (same as the .38 Colt Super-Automatic except for a slightly longer cartridge case, and very powerful), the 9 mm. Browning Short (.380 A. C. P.), the 7.65 mm. automatic, (.32 A. C. P.), and the .25 automatic.

The largest Spanish manufacturer of automatics is Bonifacio Echeverría, of Eibar, whose make is the "Star." In the larger models the Star pistols are practically duplicates of the Colt. The smaller ones are more like the Browning except for the target model .22 which is similar to the Reising formerly made in America.

Echeverría manufactures the .45 caliber automatic pistol which looks just like the Colt .45 automatic as used in the United States Army. This gun is sold extensively in Mexico and South America and uses the regular .45 caliber A. C. P. cartridge.

His 9 mm. Bergmann (.38 caliber) has external lines and dimensions the same as the Colt Super Automatic though the barrel is a bit lighter.

His .22 caliber long rifle target pistol is an automatic with a six inch barrel and the ten shot magazine and retails in Spain for about $22.50. It appeared on the market only recently but has won several rapid fire matches and is very popular.

The Astra Automatic pistol is made in the .380 and 9 mm. Bergmann calibers. It is the regulation pistol for the crack Spanish Guardia Civil.

Only recently there appeared on the Spanish market a new automatic known as the "Llama" made in Eibar and in just one model chambered for the 9 mm. Bergmann cartridge. This gun is almost an exact duplicate of the Colt Super .38. Shortly after this gun appeared it was tested by the Barcelona police and military officials for accuracy, penetration, function, and etc. under all kinds of artificially adverse conditions in tests that lasted about six weeks. In these tests all kinds of reloads and many excessive charges were used with little or no difficulty and the gun created a very favorable impression. The authorities were making the tests for the purpose of deciding on the adoption of a gun which would be official for the police and "mozos de escuadra" (rural constabulary) throughout Cataluña.

The only other Spanish automatic that seems worthy of mention in this place is the "Bùfalo" made by the old and respected firm of Beristáin y Cia., of Eibar. This is a small pocket gun of 7.65 mm. and 25 caliber and sells for a low price.

There is no model or make of hand gun which is official with the Spanish Army, the officers of which buy their own guns as they like but they generally prefer automatics using the 9 mm. Bergmann cartridge, which as made in Spain is of excellent quality and not expensive. A census of hand guns among Spanish Army Officers would show that most of them use the "Star" or the "Astra" in the large 9 mm. models.

CHAPTER 5

TECHNICAL NOTES ON HANDGUNS

ALL THE arms discussed in this book, whether they be revolvers, automatics, or target pistols, have one object in common, and that is to project a bullet accurately in a desired direction and they all have a main feature of their construction in common, in that the most important part is a strong metal tube through which the ball is launched toward the spot to be hit. This tube is called the barrel, and in the first firearms it was merely a smooth cylinder, like the present day shotgun barrel. While such a tube will, it is true, launch a ball in the direction in which it is pointed, it is highly unsatisfactory for accuracy, for the ball will not continue in the direction in which it is started. Instead, it either shoots violently off in some unexpected direction, or more usually, curves away from its original direction.

This curve in the flight of a ball is familiar to everyone who has ever seen a baseball game. The pitcher, in throwing the ball, causes it to spin rapidly on its axis, and this spin, coupled with its forward motion through the air, causes the air which is compressed in front of the ball by its forward motion to be pushed to one side; and the resultant reaction causes the ball to deviate from its flight. The same thing causes the deviation of a ball when fired from a smooth-bore gun. Unless it fits the barrel very tightly, it bounces from side to side during its sudden passage through the bore, and as it strikes against the walls of the barrel, it acquires a rotation which causes it to curve in some undetermined direction, depending on which kind of rotation it happens to have imparted to it. Or if it doesn't bounce along, it rolls on the bottom of the bore, and acquires a rotation which makes it drop rapidly after leaving the muzzle.

If the ball fits the bore tightly enough so that it neither rolls nor bounces, the case is still worse, for then it emerges from the muzzle with no rotation at all, and as it passes through the air it piles up a cone of compressed air in front of it, until, at some unknown instant, the point of this cone gets on one side or the other of the ball, and it shoots off in the opposite direction. This same effect is seen in baseball under the name of the spit-ball, where the pitcher avoids giving any rotation at all to the ball when he pitches it, and as a result, it "breaks" in some undetermined direction in some point in its flight, and so fools the batter.

Rifling

In modern firearms, these troubles are overcome by constructing the barrel so that the ball will receive a definite rotation in a given direction. In this case, it will curve, but the curve will always be the same, and can be taken into account in aiming.

In practice, this is accomplished by what is known as "rifling," which consists of making a number of spiral ribs on the inside walls of the barrel. These ribs, or "lands" as they are called in firearms parlance, bite into the bullet in its passage through the bore, and force it to turn as it passes along.

When a round ball is fired in a rifled gun it turns during its flight either to the right or to the left, depending on the direction of the rifling in the barrel. Some barrels are rifled with the lands making a clockwise spiral, and this is called right hand rifling. On the other hand some guns have a counter clockwise spiral, known as left hand rifling. There is no difference in the effectiveness of the two directions but there is a difference in the direction pursued by the ball after it leaves the muzzle. A ball fired from a right hand rifling curves to the right. This curve is called "drift." Left hand rifling gives a curve to the left or left hand drift.

When the round ball fired from right hand rifling rushes toward the target it is also falling toward the ground at the same time under the action of gravity. Naturally the air underneath the ball is somewhat compressed by this falling; and as the ball spins to the right it rolls on this layer of compressed air and hence drifts to the right. As a falling body falls faster and faster under the action of gravity so there is more and more compressed air under the bullet as it moves along, and this makes it drift faster and faster to the right. The drift during the first few yards of flight is so small that it can scarcely be detected, and for this reason drift is relatively unimportant for revolvers and pistols where the shooting is all done at relatively short ranges. The drift with the .38 Special is approximately 1 inch at 50 yards.

In the days when rifling was first invented, round balls were used exclusively; but the adoption of rifling had another effect besides merely stabilizing the flight of a round ball, for it enabled the use of oblong or cylindrical projectiles, because the spin keeps them end on in the same way that it makes a spinning top stand up. A cylindrical projectile is much more effective ballistically than is a round ball because for the same weight there is less surface presented to the air and thus the speed of the bullet is not retarded so quickly. Practically all modern rifle and pistol bullets are cylindrical, with a pointed nose.

In practice, rifling is put into gun barrels by the process of cutting spiral grooves in the bore. The ridges of metal that are left between the grooves form the "lands."

It is common to designate rifling by the number of inches of forward motion of the bullet for each complete rotation. Thus for example, the service Springfield rifle is said to have a rifling of one turn in ten inches because a bullet in passing through ten inches of the barrel makes one complete revolution.

With a round ball almost any twist of rifling that will keep the bullet spinning at all will be sufficient for accuracy; but with the modern, cylindrical bullet another factor enters, and that is stability. An oblong bullet tends to tumble in flight, and the longer the bullet, the more pronounced is this tendency and the faster must be the spin to keep it going point forward. For this reason a .22 short requires less spin than the .22 long rifle. The standard twist for rifles in the .22 short is one turn in twenty-four inches, while the .22 long rifle requires a twist of one turn in sixteen inches. Where two kinds of cartridges are to be used in the same gun it is made with the twist suitable for the longer bullet. In other words a rifle made to use both the .22 short and the .22 long rifle cartridges would have a twist of one turn in sixteen inches which is not so good for the short.

In general revolvers have rifling with faster twist than that used in rifles of the same caliber. This is because the bullet must spin a certain number of revolutions per second to give it gyroscopic stability and keep it end-on. In a revolver it has less velocity, and therefore goes less feet per second than it does in a rifle, and therefore the bullet must rotate more times per foot in a revolver to get the same number of rotations per second. An idea of the usual American practice in the matter of the twist of rifling may be obtained from the tabulation given on the following page.

TWIST OF RIFLING (INCHES PER TURN) IN AMERICAN HAND ARMS

Caliber	*Colt Twist*	*H. & R. Twist*	*I. J. Twist*	*S. & W. Twist*
.22 Revolvers	14	12	15.75	10
.22 Pistols	14	16	....	15
.32 S. & W. and Colt N. P.	16	12	23.33	18.75
.32 Winchester (.32-20)	16	20	....	12
.38 S. & W. and Colt N. P.	16	12	23.33	18.75
.38 Special	16	..	....	18.75
.38 Winchester (.38-40)	16	..	....	20
.41 Colt	16	..	....	....
.44 Russian	16	..	....	20
.44 Special	16	..	....	20
.44 Winchester (.44-40)	16	..	....	20
.45 Colt	16	..	....	20
.455 Eley	16	..	....	20
.25 Automatic	16	..	....	....
.32 Automatic	16	12	....	12
.35 Automatic	..	..	....	12
,380 Automatic	16	..	....	12
.38 Automatic	16	..	....	....
.45 Automatic	16	..	....	14.6

The usual American practice is to make the rifling with a right-handed twist, and all American made arms except the Colt pistols and revolvers have right handed rifling. Colt guns, on the contrary all have the rifling left handed, which is the English practice. The reason for this is that after the failure of Col. Colt's first factory in America, he went to London and made his revolvers there for some years; and as the rifling machines in use there were adapted for a left handed twist, Colt used it, and the Colt guns have been made the same way ever since. Many English guns have left handed rifling, but those made by Webley & Scott, as well as most arms made on the continent of Europe are right handed.

The number of grooves in common use varies from four to eight. As an indication of current American practice the following may be noted:

Colt guns all have 6 lands and grooves.
Harrington & Richardson guns all have 6 lands and grooves.
Iver Johnson revolvers all have 5 lands and grooves.
Remington .32 and .380 Automatics have 7 lands and grooves.
Savage .32 and .380 Automatics have 6 grooves.
Smith & Wesson .32 and .35 caliber automatic pistols, .22 caliber revolvers and single shot pistols, and .45 revolver model of 1917 have 6 lands and grooves. All other Smith & Wesson arms have 5 lands and grooves.

In general the depth of the grooves is from three and a half to five thousandths of an inch, depending on the ideas and experience of the manufacturer concerned, and on other factors of the design, such as the relative width of the lands and grooves.

Rather complete particulars regarding the twist and depth of rifling, number and width of lands and grooves, dimensions of bore and rifling, and all other dimensions available is given in the tabulation in the appendix.

Usually the bore, which is the diameter of the barrel before it is rifled, and consequently is also the diameter across lands after rifling, is chosen so as to be about one or two thousandths of an inch smaller than the diameter of the bullet to be used in the gun. Some manufacturers use a smaller bore for the same bullet than do other makers. This does not necessarily mean that the bullet is a tighter fit, however, for the manufacturer with a small bore will usually be found to be using deeper grooves or wider grooves and narrower lands to compensate for the reduced diameter across the lands, and the ultimate fit will be about the same. When the gun is fired, and the bullet passes into the rifling, the excess metal displaced when the lands cut into the bullet goes to fill the grooves. If the fit is either too tight or too loose, the accuracy will suffer.

The differences in the barrel dimensions used by the different makers is well illustrated by the following measurements, taken from four highly accurate .22 pistols in the author's possession.

	Smith & Wesson Perfected	*Harrington & Richardson U. S. R. A.*	*Buchel Free Pistol*	*Stotzer Free Pistol*
Barrel length, inches	10	10	13⅜	12
Sight Radius, inches	10	9.2	15⅜	14⅝
Twist of rifling, inches	15½	16	15⅝	14⅝
No. of lands and grooves	6	6	8	6
Width lands	.0496	.0304	.012	.027
Width grooves	.0635	.0835	.075	.085
Diameter lands	.216	.2141	.214	.214
Diameter grooves	.2232	.2175	.2230	.2231
Depth grooves	.0036	.0027	.0045	.0045

It will be noticed that the latest of these four pistols, the Harrington & Richardson, has the smallest barrel diameter. These measurements, taken from guns made several years ago, cannot be taken to be the present standards of these manufacturers, as changes in guns may be necessary from time to time to keep up with new types of ammunition, such as the high speed .22's, etc. In fact, one of the troubles of both the gun and ammunition makers is the lack of a real standard for either gun dimensions or ammunition sizes. For example, the .22 Caliber cartridge was originated by Smith & Wesson many years ago, with a bullet size of .226, but as the years went along and some makers reduced the sizes of their .22 caliber bullet, it became necessary for the gun makers to reduce the bore size of the gun to keep pace.

Major Douglas B. Wesson informs me that he has recently (1934) encountered .22 caliber cartridges with bullets only .217 inch in diameter, and has had to change the bore dimensions of the K-.22 to a slightly smaller size than was formerly used in order to maintain the maximum accuracy in machine rest tests.

In rifles and single shot and automatic pistols, where the chamber of the gun is continuous with the barrel, instead of being separate, as it is in revolvers, the rear end, or origin, of the rifling, comes right up to the point where the bullet lies when the cartridge is in the chamber, so that any forward motion of the bullet will make the rifling cut into the bullet metal. This part of the rifling is usually cut or chambered away in a cone shape, so that the bullet can enter the rifling easily. This coned part is called the bullet seat or "lead."

Frequently it may be desirable to see just what form the rifling has, or to make measurements of the width of the lands and grooves. The best way to accomplish this is to make a cast of the inside of the barrel. Take a lead bullet of the same caliber as the barrel, start it in from the breech, and drive it half way through the barrel with a rod. Then put another rod, as near the barrel diameter as may be available, into a vise, and slide the gun barrel onto this rod until the rod is in contact with the bullet. Insert another rod into the opposite end of the barrel, and take a hammer and drive against the bullet, so as to compress it between both rods. It will take the exact form of the lands and grooves. Push the lead slug out, and you will have an exact duplicate of the inside of the barrel, with lands and grooves in their correct size. It must be remembered, however, that the lands in the gun make grooves in the lead slug, so that the raised portions on the slug represent a reversed image of the grooves in the barrel.

Measurements across these raised portions with a micrometer caliper will give the exact diameter of the grooves in the gun. To get the bore diameter, take a knife and cut away the raised ribs on the slug which represent the grooves in the gun. Measure across the remaining surfaces and you will have the exact bore diameter. The width of the lands and grooves can be measured with a steel scale and a magnifying glass unless more exact instruments are available.

For obtaining an exact cast of the inside of the chamber of a gun so that measurements can be made, gunsmiths ordinarily use melted sulphur. Simply stop up the barrel just forward of the chamber with a cork or a piece of cotton waste, and pour melted sulphur into the chamber until it is full. When it has cooled it can be pushed out, and will retain its shape indefinitely. There is, however, a slight shrinkage of a fraction of a thousandth of an inch in the first 24 hours. This shrinkage can be reduced and the sulphur cast made to be a more nearly exact permanent record if it is first mixed with lampblack and camphor according to the following formula:

Powdered sulphur, 2 ounces.
Powdered lampblack, 3 grains.
Gum camphor dissolved in alcohol, 3 drops.

A material sometimes used for making casts is a metal alloy which is composed of:

26 parts lead
13 parts tin
12 parts cadmium
49 parts bismuth.

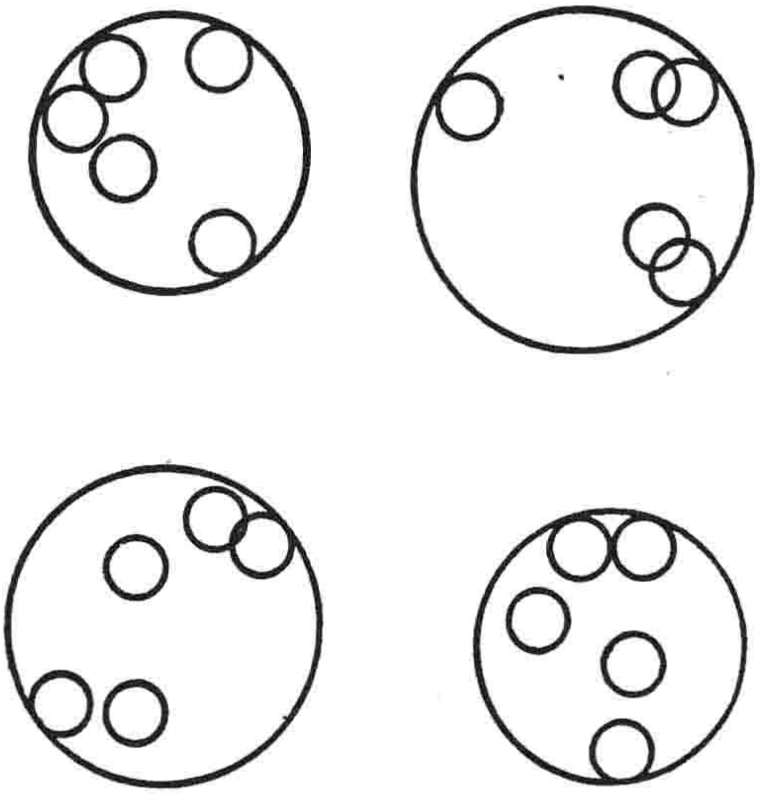
This mixture melts at the very low temperature of 158° Farenheit. It is, however, somewhat less convenient to use than the sulphur.

Barrel Length

Pistol barrels, as made today in America, range in length from ten inches, the longest barrel allowed in matches, except those shot under International Rules, down to the two inch barrel used on the Colt .25 Caliber Automatic Pistol, and on some of the pocket revolvers, such as the Banker's Special and others.

The possible effect of barrel length on accuracy is a question of much interest. Most people mistakenly believe that a long barrel is necessary for great accuracy; but this supposition has no foundation in fact. The function of the barrel on any firearm is to give the bullet its velocity, and to start it in the direction of the object to be hit. Now once a bullet starts in a given direction, it will continue in that direction until something acts on it to turn it from its path, and no matter how short a barrel is, a bullet leaving the muzzle will continue to travel in the direction imparted to it at that instant. The mere fact that it may have been going in the same direction for several feet, as it does in a long gun, before it reaches the muzzle and receives its final direction, is of no importance. On high powered rifles, a fairly long barrel is necessary in order to give space and time for the complete combustion of the powder charge, especially when progressive powders are used; and in any rifle, the barrel must be at least long enough to extend beyond the reach of the arm that supports the gun.

Experiments with .22 caliber arms has shown conclusively that little, if any, additional accuracy or velocity is to be gained by making the barrel longer than ten inches, and for years that length was the maximum allowed under match conditions in America. However, in Europe, under International Match Rules, any length up to 20 inches can be used, and in late years a few matches under these International Rules have been shot in America for the benefit of those who desire to experiment with set triggers, etc. In the past, it has been customary for contenders in the "Any Pistol" class to take advantage of all the barrel length allowed, and the regular practice in the manufacture of single shot target pistols has been to make them with ten inch barrels; but recently, in the .22 caliber matches, shorter barrels, of seven and eight inches have been finding much favor, and have been demonstrated to be capable of making the highest scores.



Four machine rest groups, (exact size) made with the 7 inch H. & R. single shot pistol at 50 yards, for comparison with similar groups made with the 10 inch H. & R. Pistol.

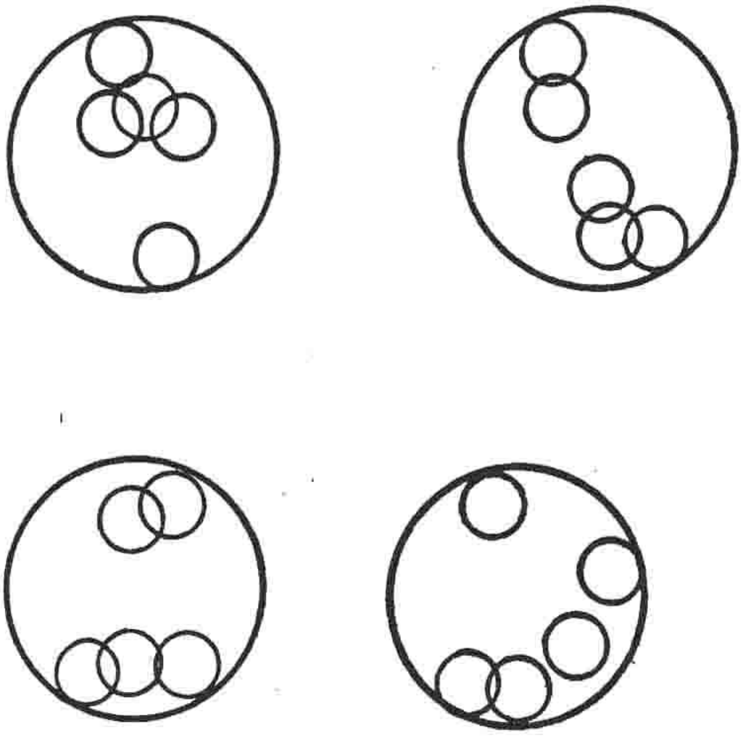
The case for the shorter barrel in the .22 is very well put by Mr. Walter Roper of Harrington & Richardson in the following letter to Mr. F. C. Ness, of the *American Rifleman:*

"Since the appearance of the account of Major Hatcher's and

Ensign Renshaw's shooting in the Bisley matches with a new 7-inch barrel Single-Shot pistol, hundreds of shooters have asked about this new pistol, indicating that the possibilities of the gun are of real interest to handgun shooters.

"How this pistol happened to be made, how the accuracy compares with the usual 10-inch gun, the actual effect of the shorter sight radius upon sighting accuracy, and the type of shooter who can get better results with the short barrel pistol are the questions we want to answer here, in as brief a way as possible.

"As so often happens, the 7-inch Single-Shot was the result of a question asked during an extensive series of 50-yard machine-rest tests of 10-inch barrel pistols. The tests had shown that the new barrel developed for the 10-inch gun was capable of making ½-inch groups at 50 yards, instead of the 1-inch groups so long considered finest 50-yard accuracy for a barrel of this length. Realizing that the modern smokeless .22 cartridge was a very different load, the question of how long a barrel was actually needed to obtain fine and consistent accuracy was a natural one.

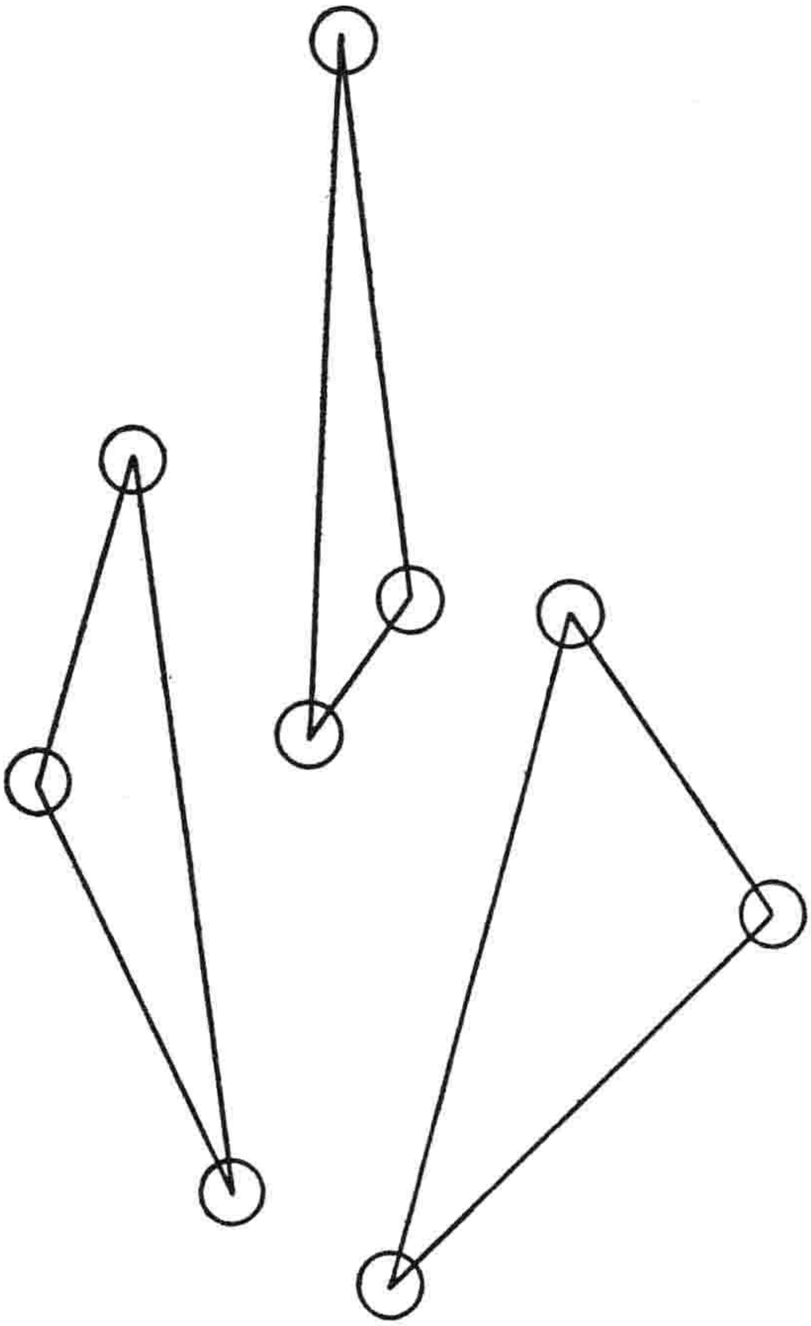


Four machine rest groups, exact size, made with the 10 inch H. & R. single shot pistol at 50 yards. Comparison with similar groups made with the 7 inch pistol. The 10 inch barrel makes only slightly better groups.

"Some 6, 7, and 8-inch barrels bored and rifled like the 10-inch barrel, were therefore made, and accuracy tests carried out. A few of the 50-yard groups made with the 7-inch barrel are shown here full size, and for comparison, some average 50-yard groups made by the 10-inch barrel gun are also shown.

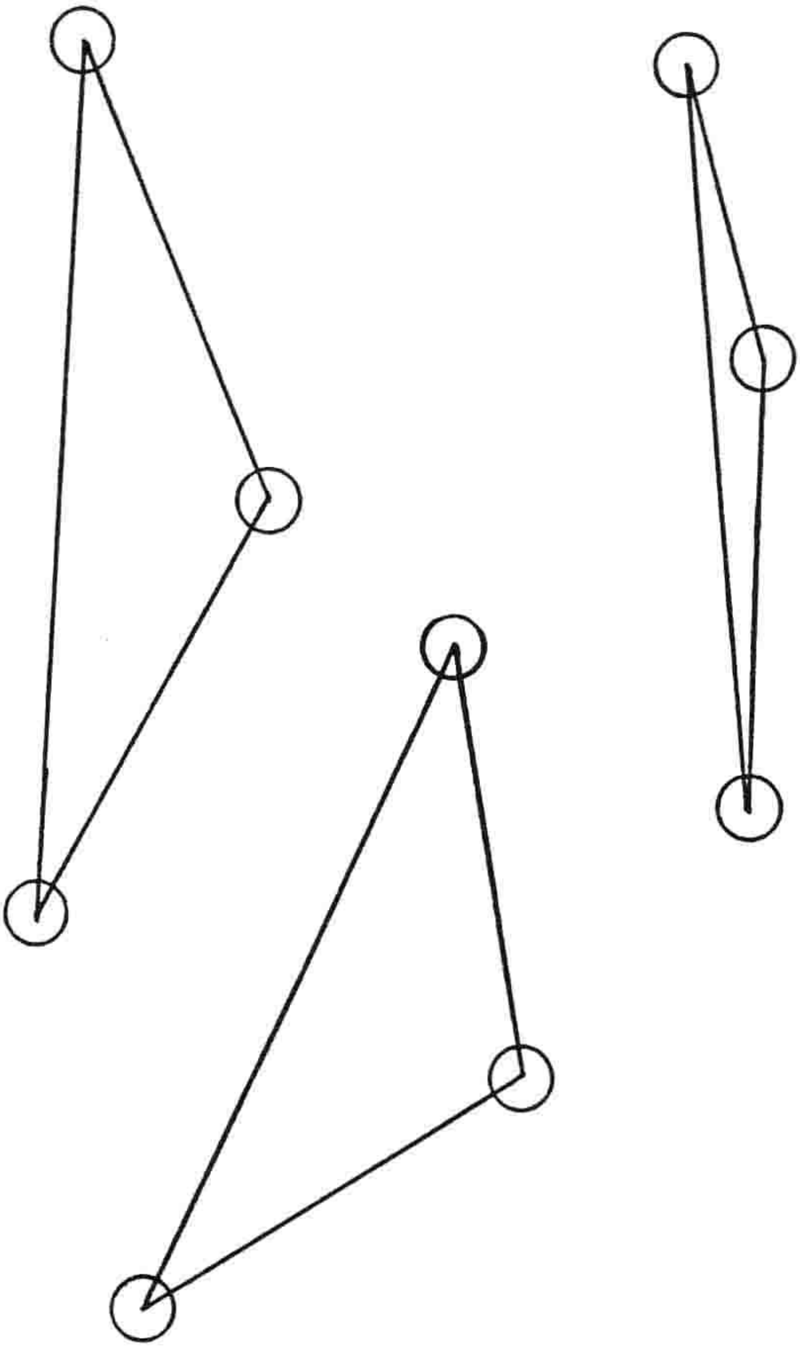
"It will be seen that the 7-inch barrel produces machine rest accuracy practically equal to that of the 10-inch gun.

"Having obtained this data, the 7-inch barrel was laid aside until some time later, when it was remembered that some shooters are able to do decidedly better shooting with a revolver than they can with the long-barrel Single-Shot, regardless of the greater accuracy of the long-barreled gun, and the question arose as to what results such shooters would obtain from an arm of greater accuracy than the revolver, but having a similar weight, sight radius, and balance.



Sighting triangles, exact size, made with a 7 inch H. & R. Pistol by the same observer and under the same conditions as the similar set made with the 10 inch pistol. A comparison indicates that if there is any advantage, it lies with the shorter weapon.

"Before asking expert revolver shots to make a test of this kind, we decided first to determine, by the use of the sighting triangle method of testing the accuracy of a shooter's sighting, just how the accuracy of sighting with the 7-inch barrel pistol compared with that of the 10-inch barrel gun. Theoretically, it should be in the ratio of 6 to 9, or only two-thirds as accurate as the 10-inch barrel gun.



Sighting triangles made at 50 yards to investigate the relative merits of the 10 inch and the 7 inch barrels on the single shot pistol. These sighting triangles were made with the 10 inch H. & R. Pistol, and another set was made by the same person under the same conditions with a 7 inch pistol. Both sets are reproduced in exact size for comparison.

"Again a surprise awaited us, for as the sighting triangles shown here will indicate, the sighting with the 7-inch gun is almost exactly as accurate as with the 10-inch. This should not be considered, by any means, as indicating that a long sighting radius is not of value, however; but it does mean that the accuracy of sighting is not in direct proportion to the distance between sights, when the sights are as near together as they must be on a pistol.

"Later experiments indicate that the sights on a 7-inch barrel gun are much more sharply defined for many shooters, and probably this permits more than enough greater accuracy of sighting to make up for any disadvantage due to the shorter distance between sights.

"Knowing that the 7-inch gun, due to the heavy barrel, would balance as perfectly as the finest revolver, and shoot with almost exactly the same degree of accuracy as the 10-inch barrel, and also that the shorter sight radius did not affect the accuracy of sighting to any great extent, it was determined to manufacture a few of these guns, and obtain reports from expert shots with both Single-Shot pistols and revolvers on shooting at both 20 and 50 yards.

"The exceptionally fine shooting of Major Hatcher and Ensign Renshaw at Bisley with one of these 7-inch guns, and the work done by many other pistol marksmen, both at the National Matches and later, shows that for many shooters the short barrel Single-Shot has features which make it able to produce even better scores than the longer barrel gun.

"The experience of many experts now clearly shows that two classes of shooters can use the short barrel pistol to advantage. First, those who have averaged to do better shooting with a revolver than with a 10-inch gun, can make decidedly better scores with this extremely accurate short barrel gun; and second, those shooters who are troubled with "fuzzy sights," as the less widely spaced on the 7-inch gun stand out much more sharply and make sighting not only decidedly more accurate, but very much more pleasant.

"Many shooters have commented upon the greater ease of sighting with the 7-inch gun, reporting that because of the less movement of the sights, they are able to get the shot away during the best part of the hold. This feature is easily understood when it is remembered that being closer together, the same angular movement will cause less motion of the sights. It must be remembered, however, that while the shorter radius produces less movement of the sights, this less easily noticed misalignment affects the accuracy of sighting to a greater extent than it would with the 10-inch gun. However, due to the more clearly defined sights, errors of alignment are more easily noticed with the result that sighting is actually more accurate, and the group obtained most pleasing.

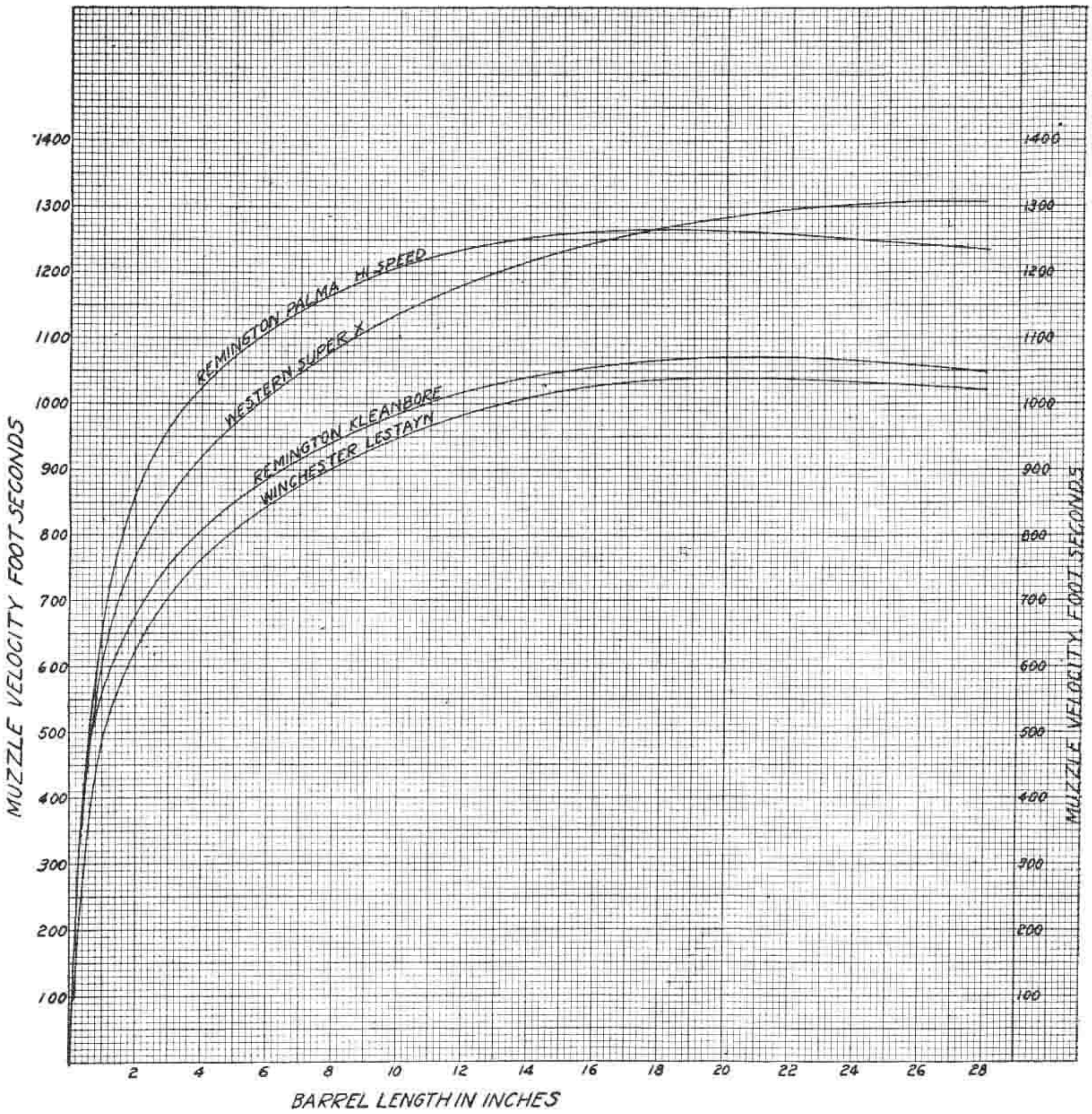
"The really expert shot with the 10-inch barrel pistol will find that his scores will be almost exactly as high with the 7-inch gun, but that he will shoot somewhat more quickly, due to the less movement of the sights, while the shooter who has done his best work with a revolver, or who has not been able to beat his revolver scores with the 10-inch pistol, will find that the 7-inch barrel Single-Shot will give him decidedly higher scores, because of the superior accuracy of the Single-Shot as compared with the revolver."

It will surprise many of our readers to learn how little is the real effect of additional barrel length on velocity, but actual tests with the .22 caliber long rifle cartridge, show that most of the velocity is acquired by the bullet in a ten inch barrel, and that after 16 inches, the velocity actually falls off with increased barrel length. This is because the powder gas expands as it follows the bullet down the barrel, and by the time it has reached 16 inches, it has little pressure left. Also, by this time the bullet is moving very fast, and the gas does little more than keep up with the bullet, without pushing very much, while all the time the bullet has to overcome the friction of the barrel.

This is very well illustrated by the accompanying graphs, made from a careful series of tests. This curve shows that with a four inch barrel, the velocity is 850 f.s., with a ten inch barrel the velocity is 1000 f.s., with a 16 inch barrel it is 1030 f.s., and with a 24 inch barrel it has again dropped back to 1000 f.s.

With revolvers, the effect is even more pronounced, as the cylinder, which is not counted in the barrel length, adds its effect, so that a two inch barrel on a revolver is about equal to a 3½ inch barrel on a pistol. The curve for the .38 Special revolver shows that with a 2 inch barrel we obtain 725 f.s., and only 75 feet more, or 800 f.s. with a four inch barrel, while adding two more inches to the barrel length and bringing it up to 6 inches adds only 30 feet more to the velocity.

An examination of the curves indicates that the difference in velocity between the six inch and the seven and a half inch barrels would be 20 foot seconds with No. 80 Powder, and 17 foot seconds with No. 5 powder. An actual test made by the author gave the following figures:



VELOCITY CURVE GRAPH

The effect of barrel length on velocity with four popular cartridges. Two of them are of the high speed type, and the other two are of the outdoor target type. See also the graphs with Chapter 8: Interior Ballistics.

The test was made with two separate revolvers, a S. & W. .38 Special Military & Police with 6 inch barrel, and a Colt Officer's Model Target with 7½-inch barrel. In addition to the regular factory loaded .38 special cartridge, with 158 grain bullet, the test included the Western .38 Special Super Police cartridge, with 200 grain bullet. The results were as follows:

	6 inch barrel length	*7½ inch barrel length*
.38 Special, Regular	850 f. s.	864 f. s.
.38 Special Super Police	705 f. s.	699 f. s.

This test shows that the regular .38 special cartridge gave 14 f.s. additional in the longer barrel, which agrees very well indeed with the figure of 17 feet taken from the curve, especially when it is realized that revolvers of two different makes were used, which may have given a slight difference even had the barrels been the same length.

The test also shows that in some cases a longer barrel may actually give less velocity than a shorter barrel. This is to be expected when a long, or very soft or very heavy bullet or a very small powder charge is used, for in this case the friction of the extra barrel length more than neutralizes the effect of the small remaining gas pressure. The test was actually made to prove a previous prediction that the Super Police load would give less velocity in a longer barrel.

A question more or less connected with barrel length is the difference in velocity between revolvers and automatic pistols. The .45 Automatic, model of 1911, has a barrel only 5 inches long, while the .45 Revolver, model of 1917 has a 5½ inch barrel in addition to the cylinder. In the revolver, of course, some gas escapes at the joint between the cylinder and the barrel; but tests have shown that generally the amount is too small to have any noticeable effect on the velocity, being usually not over 2 or 3 per cent.

A comparison of the velocities of the Automatic Pistol with the Colt and the Smith & Wesson revolvers using the same cartridge will no doubt be of interest. Five guns of each kind were used, and each gun was fired five times, using wartime ammunition, which was giving a velocity about 20 feet below the standard. The detailed results for each gun and the averages follow:

	.45 Auto. Pistol	*.45 Colt 1917*	*.45 S. & W. 1917*
Muzzle velocity, Gun No. 1	777.8	826.8	795.2
Gun No. 2	774.2	787.8	743.6
Gun No. 3	793.8	765.4	745.2
Gun No. 4	792.6	806.6	793.2
Gun No. 5	801.4	816.6	786.2
Average Muzzle velocity	787.9	800.6	772.6

While, as stated above, there has been a marked tendency toward the use of shorter barrels in the .22 caliber, the same arguments for shortening the barrel length lose much of their force when applied to heavier calibers, on account of the effect of barrel length on the recoil and jump of heavy caliber revolvers. About one-third of the recoil of the average revolver shot is caused by the reaction of the gas as it rushes out of the muzzle; and when the barrel is cut off to a shorter length, the gas is discharged into the air at a higher pressure, and the noise, blast, and recoil are all disagreeably increased.

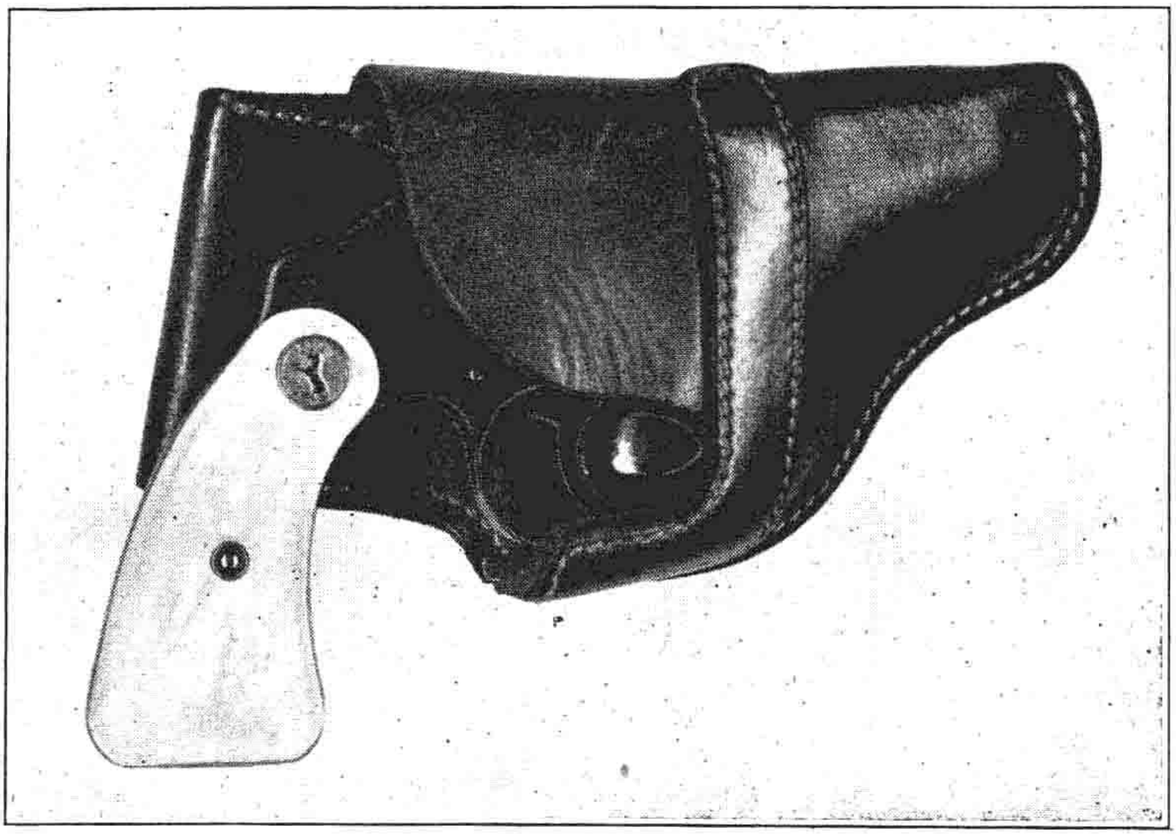
However, there is another effect which is perhaps even more important, and that is a change in the radius of gyration of the gun, allowing it to jump more. This may be explained by stating that when the gun is fired, the gas pushes straight back in line with the barrel, while the forward reaction of the hand, in holding the gun against the thrust of recoil, is applied on the grip, which is considerably below the line of the barrel where the thrust occurs. The result is that the recoil tends to swing the muzzle upwards, and the longer and heavier the barrel is, the more will its weight and inertia resist this upward rotation, or "Jump"; and the metal at the muzzle of the barrel, having the most leverage, will have the greatest effect in resisting this upward jump. By cutting off the muzzle, we reduce the radius of gyration, or resistance to upward rotation, and the result is that revolvers with very short barrels and very heavy loads, such as the Detective Special, jump very unpleasantly. In the same way, revolvers with long barrels are quiet, easy shooting arms, which neutralize the recoil and jump to a large extent, and make possible accurate shooting with heavy loads.

Thus, with large caliber guns, a barrel at least six inches long is desirable for target practice, and lengths up to eight inches are desirable for the very heavy or high velocity loads, such as the .44 and .45 and the new .38/44. All the successful target revolvers follow this rule, as for example, the S. & W. Military and Police Target and the S. & W. .44 Target, with 6 inch barrel; the S. & W. .38/44 Outdoorsman, with 6½ inch barrel, the Colt Officers model .38 and the Colt New Service Target with 7½ inch barrel; and the new S. & W. .357 Magnum, with 8¾ inch barrel.

The question of the 6 inch barrel as against the 6½, 7½, or 8¾ inch barrel is largely one of the physique of the user. It takes a strong well trained man to hold the heavy Colt's New Service 7½ inch, or the new .357 Magnum at arm's length for any length of time. A strong and vigorous man who lives an outdoor life and keeps in training can do wonderful work with one of these arms, but the average man can no doubt do better with a gun such as the 6 inch barreled M. & P. or Officer's Model.

In late years, the ultra-short barrel length of two inches has become popular for pocket revolvers to be used by peace officers, mail clerks, bank messengers, etc., and two very popular Colt models, the Banker's Special, for the .38 Colt Police Positive

Cartridge, and the Detective Special, for the .38 Special Cartridge, are made with two inch barrels. These models originated when the U. S. Postoffice Department decided several years ago to arm the railway mail clerks with revolvers that could readily be carried in the pocket, and could still use a cartridge large enough to be decidedly effective in any emergency. As a result of a conference between government officials and the arms makers, several short barreled models were submitted, and the one afterward known as the Banker's Special was the one that was finally purchased.



The Colt .22 Banker's Special in the Audley Spring Holster. This holster has a spring catch which engages with the trigger guard of the gun so that the gun is prevented from falling out or from leaving the holster at all unless the finger is placed in the trigger guard, when it comes in contact with the spring catch and releases the gun.

Recently the Banker's Special has been produced in .22 caliber, and is proving very popular as a means of providing a cheap means of obtaining proficiency with the larger gun by the use of the inexpensive .22 caliber cartridges for practice, instead of the more costly .38's. The first of these guns was made expressly to the author's order, and it is one of his favorite guns. Used with the high speed hollow point or sharp shoulder cartridges, it is itself a defensive weapon to be respected, and is capable of very satisfactory accuracy at full ranges. Another similar, though more recent arrival in the firearms world, is the Harrington &

Richardson New Defender, which is also a .22 with a two inch barrel. With it I have shot scores of over 90 on the Standard American Target at 20 yards.

While excellent shooting can on occasion, be done with these very short barreled guns, the sight radius is of course too short to allow them to compete seriously for target honors. A deviation of the front sight which is so small that it can hardly be noticed will give the shooter a six instead of a ten, and it requires the greatest of care to prevent these deviations from occurring. In fact, I am unable to do it. But in spite of that the accuracy is surprisingly good when the really very short barrel length is considered. With this little gun I averaged 84 on the standard American Target at 20 yards for several month's shooting, while with the same gun with a six inch barrel I averaged only four points higher, or 88.

Summing up the question of barrel length, it might be said that for target shooting with the single shot pistol, the ten inch length is perhaps the best for the average excellent shot, who sees the sights well, holds with extreme steadiness, and shoots promptly. However, for the many excellent shots who have trouble with blurring or fading of the sights, or who are inclined to be troubled by a tendency of the muzzle to wabble, or whose shooting temperament is such that they are inclined to hold too long before getting off the shot, the seven or eight inch length will be found to give definitely better results than the ten inch.

For target shooting with the revolver, the six or six and a half inch barrel length seems to be just about ideal, for the average man, though the unusually strong and well trained man will often prefer the 7½ inch or even the new 8¾ inch barreled guns.

For the law officer, the barrel should never be longer than four inches. The longer barrel adds nothing to the accuracy for short range work, and is much less convenient to carry and handle. Even if the gun is always carried in an outside holster on a belt, the short barrel is preferable, for it swings and handles more easily. Unless unusual compactness is desired, the three or four inch length is to be preferred to the two inch. The medium length barrels balance better, and feel better in the hand than the guns with extremely short barrels, and it is easier to sight accurately with a three or four inch barrel length than with a two inch. Moreover, the two inch barrel gives more recoil, on account of the fact that the gas escapes into the atmosphere under higher pressure, and hence the reaction of the gases on the air, which is responsible ordinarily for about a third of the recoil is increased, and as stated above, it jumps unpleasantly.

For prospectors, explorers and others in the wide open spaces of the world who may want to do long range shooting, (100 yards and over) with the revolver, the 7½ or eight inch length has important advantages. It will give about 25 foot seconds more velocity, on the average, than the six inch length, and it has a considerably longer sight radius, which is an important advantage when the revolver is shot from a steady position, using both hands, as is usual in practical long range work, when the rules of the target range do not apply, and the only object is to hit, using any available means to do so. For long range work, it is important also to choose a cartridge that has high velocity and small air resistance. The recently announced Smith & Wesson .357 Magnum with its 8¾ inch barrel and high velocity cartridge should be ideal for this work.

Weight

Modern hand firearms vary in weight from less than a pound to about two and a half pounds. The lower limit is represented by the .25 caliber automatics, weighing about 12 or 13 ounces, according to make, and such small guns as the S. & W. Safety Hammerless or the Colt Pocket Positive, weighing about a pound. On the other hand we find the large military models, weighing about 40 ounces, more or less, according to model or caliber.

Leaving out the question of recoil, a weight of about a pound and a half is a very pleasant weight for a target revolver. Certainly it is far less fatiguing to shoot with a light arm of about this weight, such as the S. & W. .22/32, or the Colt Woodsman, than it is with a heavier gun, such as the .22 Officer's Model, or the K-.22. On the other hand, when we consider other calibers than .22, we must take into consideration the question of recoil. The heavier the gun, the less will it recoil, and with very small and light revolvers which are made for heavy cartridges, such as the Police Positive Special, the punishment to the shooter's hand is sometimes rather severe, especially as the entire force of the recoil must be absorbed through a very small and narrow handle in these smaller guns.

Doubling the weight of the gun cuts the recoil in half; on the contrary, cutting the weight of the gun in half doubles the recoil. The serious part of it with these small guns is the fact that the recoil tends to turn the gun in the hand, so that the muzzle rises, and the grip is shaped so that it is very difficult for the shooter to prevent this turning, which may throw the edge of the hammer against the top of the hand with sufficient force to cause painful abrasions.

This is the reason for such heavy guns as the S. & W. .38/44, the Colt Shooting Master, and the new S. & W. Magnum. In these guns the weight and moment of inertia opposed to the recoil and turning effect of the cartridge makes a very pleasant-shooting arm.

This subject is treated at length in the section on Interior Ballistics, where the theory of recoil is stated, and a table of the actual recoil energy of the principal guns is given.

Accuracy

The accuracy of a revolver or pistol, which may be described as its ability to deliver its shots in a small group on the target, is dependent on many things, and may be affected or changed by many conditions. For example, a poor trigger pull may interfere seriously with accuracy. Other vital factors are the balance and weight of the gun, the kind of handle, the lock time, or speed of the hammer, the character of the firing pin blow, the sights, the precision with which the cylinder lines up with the barrel, the leading of the barrel, wear or erosion of the barrel, etc.

However, all of these things are more or less "accessories after the fact," for no accuracy can be obtained by the best of sights or trigger pulls unless the barrel has mechanical accuracy to start with, and is used with an accurate cartridge.

The first requisite is a barrel of the proper size, properly rifled, and having a smooth finish inside. Given such a barrel, the best accuracy is obtained when the barrel is so chambered for the cartridge to be used that when the cartridge is inserted in the chamber, the bullet rests on the beginning of the rifling. In the "Olympic" Smith & Wesson .22 pistols, the cartridge stops, with the bullet against the rifling, when it is about a sixteenth of an inch from being all the way in the chamber. Additional force must be applied to make it go the rest of the way, and this makes the rifling actually cut into the bullet, which is then all ready to start on its journey with the greatest possible uniformity and precision, and it starts to rotate at the same time that it starts forward.

On the other hand, in a revolver, the cartridge is in a cylinder which is separate from the barrel which has the rifling, so that the bullet cannot touch the rifling until it has been driven forward a half inch or more by the powder pressure. This first motion is in a straight forward direction, without any rotation at all, and when the bullet finally strikes the rifling, it is already moving very fast. At this instant it must pick up its rotation very suddenly, instead of acquiring the rotary motion gradually, in the same way that it obtained its forward speed. As a result, the bullet fails to follow the rifling at first, and the lands cut straight across the bullet until such time as a rotary motion can be imparted to it.

In the old cap and ball revolvers, in which round balls were often used, the bearing of the bullet on the rifling is very small, as only the narrow zone around the middle of the bullet touches the lands, and in order to allow the bullet to acquire its rotation gradually enough so that stripping would be avoided, the grooves were made straight in the back part of the barrel, with a gradually increasing twist. However, the modern bullets, with long cylindrical bearing do not strip so easily, and all modern revolvers are made with a uniform twist of rifling. This works very satisfactorily, but if bullet which has been fired from a revolver is examined carefully, it can be plainly seen that the bullet has moved forward against the rifling for a short distance before taking the rotation.

Perhaps even more important in its effect on accuracy is the fact that when the front end of the bullet is retarded by suddenly striking the rifling, the bullet has a tendency to tip over or turn sideways, and though of course it is restrained from doing this by its position in the cylinder it is not held as firmly in line as it would be if it were in the chamber of a single shot pistol and this tendency to turn sideways may frequently cause a considerable amount of deformation in the bullet, especially when the breech end of the barrel is eroded to a larger diameter than normal. For these reasons the single shot pistol is capable of higher accuracy than can be obtained with revolvers.

By this it must not be inferred however, that modern revolvers are inaccurate. Quite the contrary is true, for a great deal of ingenuity and engineering skill has been expended in bringing the accuracy of the revolver to the highest possible point, and the results have been extremely satisfactory. It is true that revolvers do not ordinarily place all of the shots in one hole, yet the good ones make groups that are very much smaller than the ten ring on the target and the dispersion given by the revolver is only a small fraction of that which is due to the errors of the shooter.

An index of what the revolver is capable of is shown by three consecutive groups of nine shots each (the capacity of the cylinder) fired from a machine rest at fifty yards. The largest of these groups was 1¼ inches in diameter and the smallest was slightly under an inch. All three of the groups could be placed in separate positions inside the ten ring so that no group would come within half an inch of any other group or within half an inch of the ten ring which is 3.39 inches in diameter. This shows that if the target shooter could hold as well as a machine rest and could see his sights perfectly, he would be capable of shooting possibles all day long. The errors of the shooter are so much greater than those of the average gun that barrel accuracy is very seldom a deciding factor in winning a match.

Among the factors which affect the accuracy of a revolver is the length of the cylinder and the distance the bullet has to jump before it hits the rifling. Most .22 caliber revolvers have a cylinder that is much longer than necessary. This is because most of them were designed to take a larger cartridge and when they are made for the .22 the chambers are simply made smaller without shortening the cylinder which could change the whole design of the gun and result in very great manufacturing expense. In modern, high grade revolvers chambered for the .22 caliber cartridge the cylinder is approximately ¾ of an inch longer than necessary for the .22 caliber long rifle cartridge. This could readily be changed merely by making the cylinder only as long as necessary leaving a gap in the frame in front of the cylinder; and extending the breech of the barrel back beyond the frame so as to meet the cylinder. Experimental models of this kind have been made but such a gun could not be sold because it looks awkward and the average public is more interested in looks than in very fine accuracy. Moreover, the accuracy already obtained is so good that the amount to be gained by such changes is not important enough to justify the trouble involved. It will be found, however, that some makers have decreased the forward end of the chamber in the cylinder so that it is a tight fit on the bullet.

Much more important than length of the cylinder is the precision with which it lines up with the barrel. If the cylinder is not exactly in line it can readily be seen that the bullet will strike more heavily on one side of the rifling than on the other, and will be deformed. Moreover, if the cylinder is considerably out of line, shaving of lead will result, with a considerable loss in accuracy and with possible injury to the shooter. The pieces of lead that are scraped off by the back of the barrel when the bullet enters are thrown out to the side and may strike the shooter on the hand or be thrown back into his face. This may be caused by a worn cylinder lock, or in cheaply or poorly constructed weapons, by faulty design. It is a dangerous and annoying defect.

The writer once owned a .44-40 single-action revolver which got to shaving lead, owing to wear of the hand cylinder and lock, and after the defect was corrected by replacement of the worn parts, the gun still could not be used with satisfaction due to a tendency to flinch caused by the memory of the particles of lead flying in the face at the time of the defect. As a result the gun was disposed of, although it was then working correctly.

Poorly made revolvers may not have the holes in the cylinders bored in perfect relation to each other and as a result the shaving of lead will occur. This defect is very rare in well-made weapons and is one of the reasons why cheap and poorly constructed revolvers of foreign make should be avoided.

In guns in which the cylinder swings out to eject and reload, as is the case with most modern American revolvers, the direction of rotation of the cylinder has an important bearing on the proper lining up of the chambers with the barrel, for if the rotation is to the right, or toward the frame of the revolver, the thrust of the "hand" or pawl that turns the cylinder, tends to push the crane and cylinder toward the frame of the gun, but if, on the other hand, the rotation is to the left, the thrust of the hand tends to push the crane and cylinder away from the frame of the gun, so that the cylinder would thus be slightly swung out from its proper position, and would not line up with the barrel.

Both the Colt and the Smith & Wesson .38 caliber Army revolvers which were used as the Service sidearm before the adoption of the automatic pistol had left hand rotation, which was undesirable. The Colt guns of this model often shaved lead very badly, but the Smith & Wessons were extremely well made, and I have never seen one of the old Army .38 S. & W.'s give this trouble. I have been told by members of the Smith & Wesson firm that they did not want to use the left hand rotation, but were forced to make their army revolvers that way to meet Government specifications of those days.

In their later revolvers, the Colt company changed the rotation to right-handed. Smith & Wesson retained the left hand rotation, but took steps to insure that the cylinder is always properly lined up with the barrel by the use of an additional cylinder latch made on a lug underneath the barrel, and arranged to engage the front of the ejector rod. This double latching is a feature of all modern Smith & Wesson revolvers having swing-out cylinders.

In inspecting guns at the factory they are tested for the precision with which the cylinders match the barrel, by using a testing plug called a "range rod" which is a steel rod that just fits inside of the barrel with a snug fit. In making this test the gun is snapped and the trigger held back and then this rod is pushed down through the muzzle until it enters the chamber in the cylinder. If it meets resistance in going into the chamber it shows that the cylinder is not properly lined up.

Even if the gun is properly constructed and meets this test it may become loose as a result of wear, so that the cylinder may not line up properly. For example, if the notches on the cylinder and the hand that engages in these notches to turn the cylinder become worn the cylinder may not turn far enough for the latch to drop into place; thus the cylinder would not be properly lined up with the barrel when the gun fired. In fact with old guns it is sometimes the practice of the user to touch the cylinder lightly with the forefinger in order to be sure that it is properly locked in place before pulling the trigger.

In buying a second hand gun it is a good plan to test it by holding back the cylinder with one hand and cocking the gun with the other so that if the parts that rotate the cylinder are worn, their defective condition can be detected. Then with the gun empty, cock the hammer and pull the trigger; and without releasing the pressure on the trigger rock the cylinder from side to side to see if there is any play. There should be very little, if any, motion in this position of the gun, that is, with the trigger pulled back all the way, because this is the position in which the gun is at the instant of firing and if there is any looseness of the cylinder it is likely to be on one side or the other of its proper position which will result in the shaving of lead and consequent inaccuracy.

Firing Pin Blow

Even though the gun should have excellent accuracy in the barrel and should be in good mechanical condition as regards the alignment of the cylinder there is still a chance for trouble if the firing pin blow is not correct, for if the blow is too weak hangfires and inaccuracy will result. Of course if the blow is extremely weak the cartridge will not go off at all and there will be a misfire instead; but any weakening of the blow is bad for accuracy, even though the trouble may not be severe enough to result in actual misfires.

The .22 rimfire cartridge is particularly sensitive to variations in the firing pin blow. As an illustration of what may happen I will describe an incident that occurred a short time ago. A rifle club had some Springfield .22 caliber rifles and also some Winchester .22 caliber rifles. They also had two makes of .22 caliber ammunition in stock. The President of the Club came to me for advice stating that he was having great difficulty with one of the makes of ammunition. The accuracy was extremely poor and many of the bullets would not even reach the target at fifty feet. We went over to his club, took a brand new rifle out of the locker room and proceeded to fire fifty shots of both kinds of ammunition with excellent results. There was no trouble whatsoever and the Club President who had made the complaint was dumbfounded. I knew that he had undoubtedly been experiencing severe trouble, and I was puzzled to know why we did not get it in this test, so I questioned him further as to the rifles that had given the trouble. He then informed me that half of the rifles including the one we had just tried, were brand new ones which had never been used; while the remaining half had been in use for several years and were quite well worn. He said that all of the rifles that they had been shooting had given trouble. I then got one of the actual rifles that had been used and made a test with the result that ammunition "A" worked perfectly while ammunition "B," which was the one he complained of, gave about 25% of hang fires, squibbs, low reports, etc., and those shots that did reach the target were strung all the way from the bullseye to the bottom of the paper. A further test showed that both ammunition "A" and "B" gave perfect results in the new rifles while ammunition "A" gave perfect results in the old, worn rifles and ammunition "B" was the next thing to entirely useless in these old rifles. In the same way a brand new lot of ammunition purchased by the Government failed to function in .22 caliber automatic pistols although it had passed a perfect acceptance test just a few weeks before. A retest of all this ammunition was made and again it passed a perfect retest, but these tests were made in rifles and not in pistols. Investigation showed that the firing pin blow in the pistol was very much lighter than in the rifle.

As a result of this test and of other similar experiences the Ordnance Department made up a testing device for measuring the firing pin blow in all types of weapons. In the .22 caliber weapons a cartridge made of solid copper is placed in the chamber of the gun and the firing pin was snapped on it. The depth of the indentation is then read by means of a dial indicator gauge. This gives a very accurate measure of the actual strength of the firing pin blow. For other types of guns steel cartridges are furnished with the outfit, one cartridge for each type of gun to be tested. Instead of a primer each one of these steel cartridges has a hole for the insertion of a little copper cylinder. To make the test, the copper cylinder is placed in the steel cartridge, which is then placed in the gun. The gun is then snapped and the depth of the indentation is measured as before.

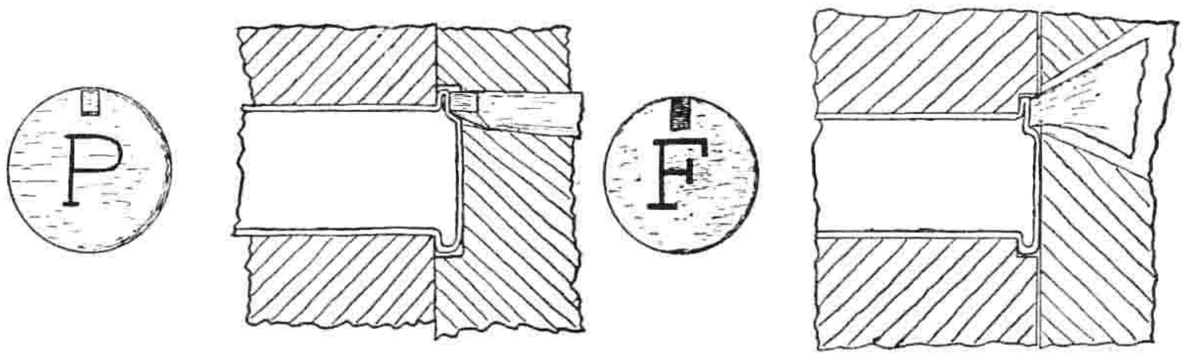
During my experiments with this subject I made tests not only on fresh ammunition of different kinds but also on various old lots of ammunition that had been kept for some years and I found that with a light firing pin blow or in some cases even with a fairly heavy blow and some changes in the point of the firing pin that trouble would be experienced with many makes of ammunition. On the other hand with some other shapes of firing pin and sufficiently heavy blow even the old stale ammunition seemed to work very well. In the course of this investigation I tested the firing pin blow of a number of different guns in my possession with the results shown below:

Name of Gun	*Depth of Blow (Inches)*	*Remarks*
Fiala Combination	.005	Many misfires with this gun.
Colt Ace	.007	Hang and misfires with some makes.
Savage Rifle	.010	
Reising Auto. Pistol	.011	
Smith & Wesson Olympic .	.011	Bad results with smokeless, excellent with Lesmok.
Winchester Single Shot ...	.013	
Colt Officer's Model	.0135	Single action.
Colt Officer's Model	.010	Double action.
H. & R. 10″	.014	
H. & R. 8″	.015	
Iver Johnson Sealed Eight	.014	Chisel shaped firing pin.
Iver Johnson Sealed Eight #2	.0085	Firing pin with egg shaped point.
H. & R. Sportsman	.015	
Winchester 52 with Speed Lock	.015	
S. & W. K-22	.015	Single action.
S. & W. K-22	.013	Double action.
Colt Woodsman	.016	
Webley Single Shot	.023	Excellent results with all ammunition.

As the result of these tests and of troubles encountered with some of the guns and certain makes of ammunition an extensive correspondence ensued between the author and several of the manufacturers concerned, with the result that some changes were made in firing pin shapes and blows, so that the table given above does not necessarily represent the present practice of the makers represented in the tabulation.

The uniformity and certainty of ignition, and consequently, the accuracy, is affected not only by the strength of the firing pin blow, but also by several other factors, such as the headspace, the character of the support for the rim of the cartridge, the shape of the firing pin point, the location of the blow as regards the edge of the rim, etc.

"Headspace" is the distance between the breech of the gun and the support for the cartridge rim; in other words, it is the space occupied by the head of the cartridge when the gun is loaded. If it is too small, the gun cannot be closed after loading; this condition is not met in practice. If it is too large, ignition troubles may ensue from the fact that the cartridge is not held firmly against the breech of the gun, and may be so far away that the firing pin dents the primer only slightly; or the cartridge may rest against the breech, but may move forward when struck by the firing pin. Headspace should be no greater than necessary to allow loading the arm with all makes of cartridge. The more nearly the head of the cartridge fills the space between the barrel and the breech block, the better are the ignition conditions.



A STUDY OF FIRING PIN ACTION.

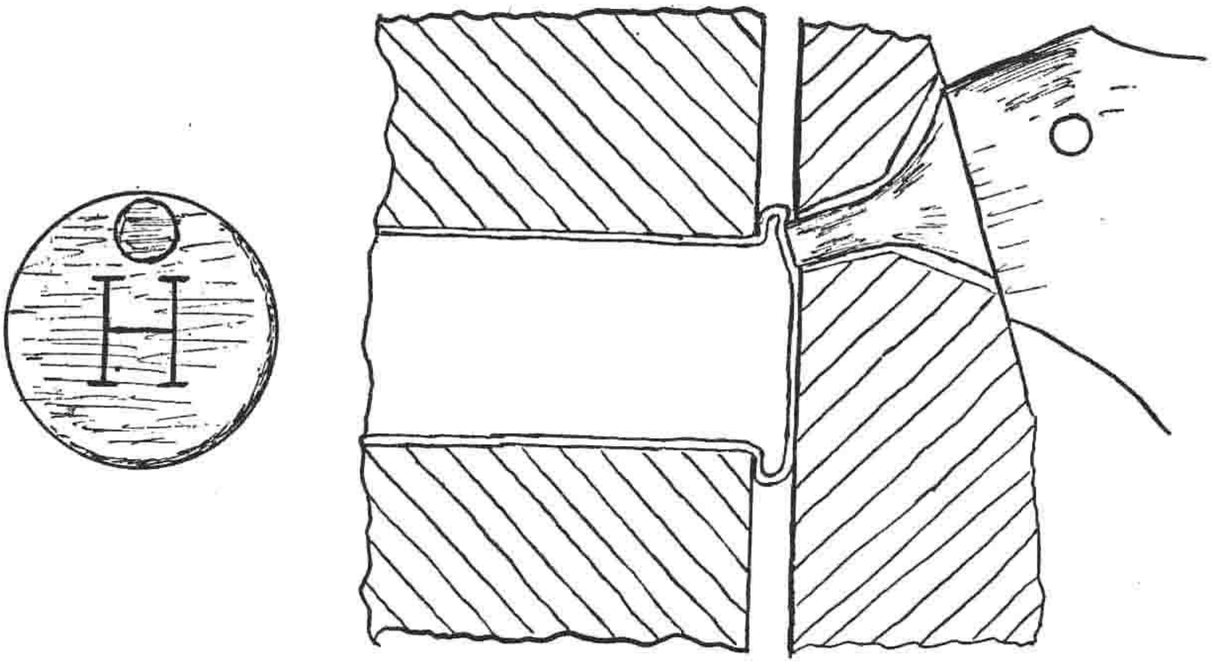
Left: **The Colt Woodsman and the Colt Ace. The chisel shaped point of the** firing pin strikes nearly across the rim; just slightly inside. The chisel shaped or rectangular point is probably somewhat better than the round shape, as the force of the blow is concentrated where it is most needed.

Right: The Colt **Officer's Model Revolver. The point of the hammer nose, which** is rectangular in **shape, forms the firing pin, which strikes across the rim right to** the edge. It gives excellent ignition.

The character of the support for the head of the cartridge is important, especially in rim-fire cartridges, for if the rim is not firmly supported against the firing pin blow, the result will be unsatisfactory. In some single shot pistols especially, the part of the rim that receives the blow rests on the extractor, instead of the solid part of the barrel. This is not a desirable condition.

Most firing pins for center-fire cartridges have a rounded point, but there is a tremendous variation in the shapes used for rim-fire cartridges, hardly any two makers using exactly the same kind of point. Some firing pin points are round and flat on the end, like the end of a rod; others are round with a ball point; still others are chisel shaped or rectangular. In addition, there is a large variation in size. Some makes of gun have a large diameter firing pin, that covers a large area, while others have only a small point. Perhaps a mean between the two extremes is the most desirable, for too small a firing pin may strike a spot on the rim of the cartridge where there does not happen to be much priming, while too large a pin has to mash so much metal that the blow must be very heavy, and the jar on the mechanism is thus increased.

If a number of dummy .22 caliber cartridges are snapped in several makes of gun, it will be seen that there is also a large variation in the location of the impact as regards the edge of the rim of the cartridge. For example, one make may strike entirely inside of the rim, while another may strike half on the rim and half outside of it. Obviously, a firing pin that strikes a rim-fire cartridge well inside the rim will give poor ignition, for best results are obtained only when the mixture is actually crushed between the



A STUDY OF FIRING PIN ACTION.

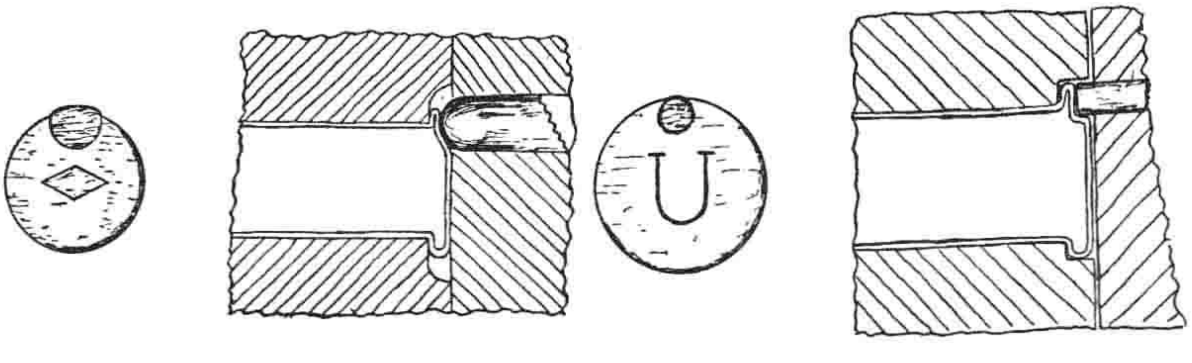
The author's old Smith & Wesson Perfected Single Shot Pistol. The small round end of the pivoted hammer nose acts as a firing pin. It strikes well inside of the rim, and does not give particularly good ignition with any but the most sensitive primers.

front and back parts of the rim, and this means that the blow must fall on the rim, not inside of it.

The edges of the firing pin should be somewhat rounded, for sharp corners will have a tendency to puncture the thin, soft metal, with a resulting disagreeable or even dangerous escape of gas.

Another unfavorable condition is for the firing pin to strike too far toward the outside edge of the cartridge case, for then instead of smashing the hollow rim of the cartridge much of the energy of the blow will be wasted in trying to compress the outer wall of the cartridge head. These difficulties are most often seen in guns which have a round firing pin. In order to overcome troubles of this kind many guns have an oblong or chisel shape point to the firing pin which cuts right across the rim. This type of firing pin is very satisfactory but care must be taken that the corners are well rounded and that the firing pin is not wedge shape or sharp at the front, as otherwise it might cut through the thin metal and cause a ruptured head with an accompanying disagreeable escape of gas.

Firing pins on the Smith & Wesson straight line and K-.22 and on the Harrington & Richardson revolvers are round. The firing pin on the Colt .22 caliber revolvers, the Camp Perry model, and the Woodsman and Ace pistols and on the Harrington & Richardson U. S. R. A. model pistols are rectangular in shape. An interesting firing pin or hammer nose is that on the Webley single shot target pistol which is similar in shape to the firing pin used on the Colt and H. & R. pistols as described above but has the striking surface rounded into a cylinder. This is probably made necessary



A STUDY OF FIRING PIN ACTION.

Left: The Stevens Conlin Model Target Pistol. The sketch shows a cross section through the chamber and breech of the gun, to give an idea of the manner in which the rim is crushed by the blow. The appearance of the cartridge head after firing is shown at the left. This gun has an exceptionally large firing pin with a rounded point, which not only covers the rim of the cartridge, but actually extends some distance beyond.

Right: The Smith & Wesson Model K-.22. The small round firing pin strikes squarely on the edge of the rim. This is where the blow should be struck for the best results.

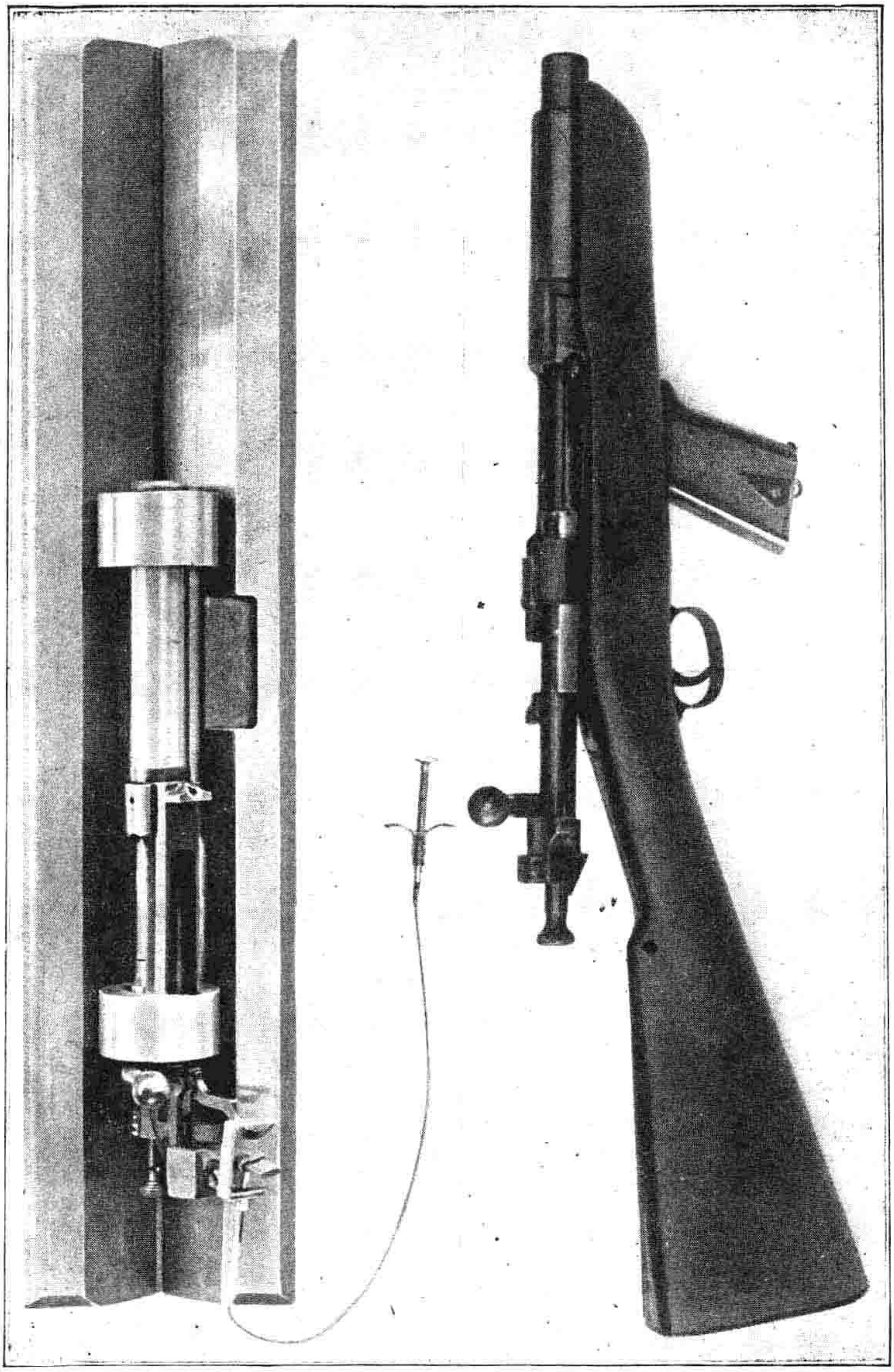
by the very heavy blow which might cut through the metal if sharp edges were used on the rectangular face of the firing pin. This rounded surface together with the very heavy impact used is very effective and the ignition with this pistol seems to be excellent as it fires without trouble old and deteriorated cartridges which give misfires and hangfires in other guns.

Firing pin location is important in center fire cartridges as well as in .22's. Quite often revolvers and automatic pistols are seen in which the cartridge is not struck squarely in the center of the primer. In fact this is the rule rather than the exception even with many high grade arms. As long as the eccentricity of the firing pin blow is relatively small it does no harm; but if the blow is very far off center misfires are likely to occur.

Testing Guns for Accuracy

While a good shot can readily detect any *serious* lack of accuracy in a pistol or revolver by shooting it at a target, it is almost impossible to satisfactorily compare the accuracy of well made guns by this method, because the average high-grade arm will shoot much closer than even the best shot can hold. Even a champion shot cannot expect to make a group much less than six or eight inches in diameter at 50 yards, and yet groups of less than one inch in diameter at this distance are the rule in testing .22 caliber target pistols from a machine rest.

It would seem that the obvious solution would be to use a machine rest for testing the accuracy of all pistols and revolvers; but unfortunately this is not possible, because no satisfactory machine rest for heavy caliber hand guns has ever been devised. With rifles, the problem is comparatively simple. The gun is clamped by the barrel, receiver, and butt, or, preferably, by the receiver and butt alone, onto a heavy clamping device mounted on a massive concrete base. The strength of the parts is such that the gun cannot move between shots. It would seem that this should give a perfect test, but experience has shown that great care and skill are necessary in bedding the gun properly in the rest, and in clamping it so that no strain or distortion results. Even with a gun skillfully placed in the rest, the effect of heating between shots may destroy the accuracy of the test. In fact, so great are the difficulties involved, that for testing the accuracy of ammunition even this method is not good enough, and such tests are usually made by means of a testing device called the "Mann Rest," after the late Dr. F. W. Mann, who invented it during the course of an extensive series of tests on accuracy.



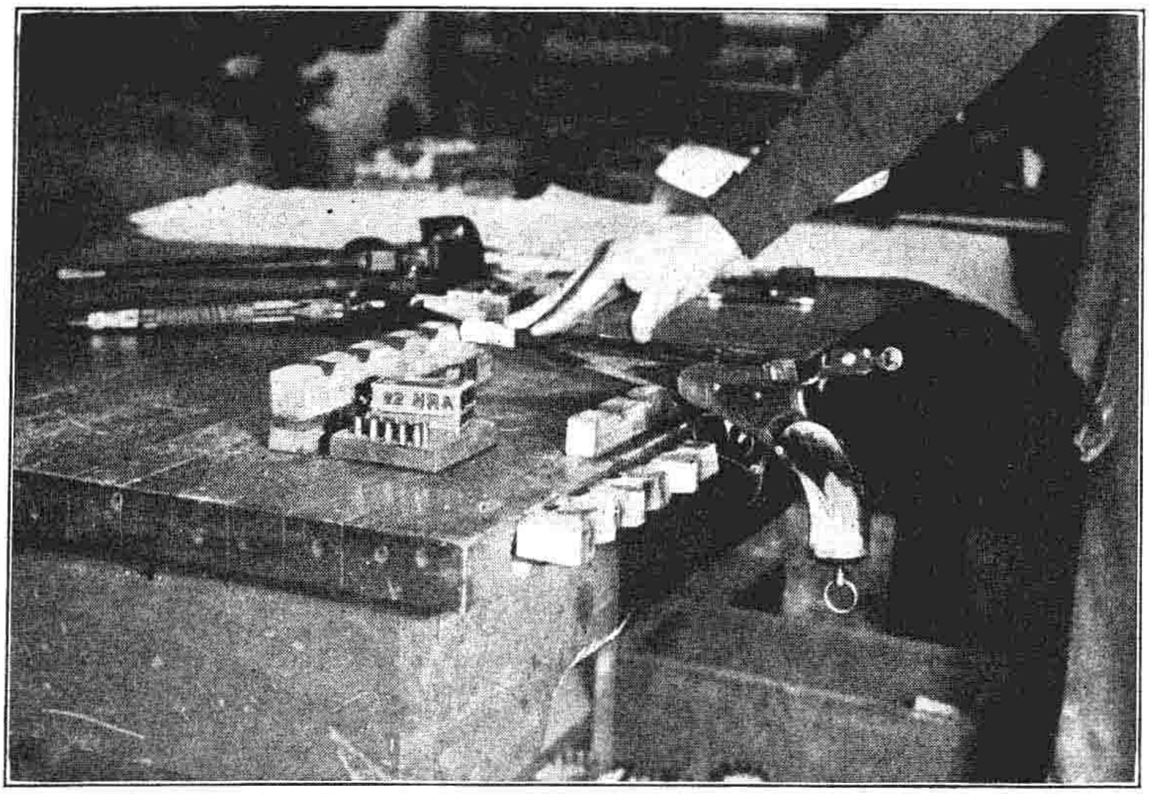
Left: Special Mann Barrel developed to test .45 Automatic Pistol Ammunition. Note the camera release used to pull the trigger without communicating a jar to the barrel. **Right: A .45 caliber accuracy gun for use in a machine rest. The 5 inch .45 caliber barrel is fitted to the receiver of a Springfield Rifle.**

The Mann Rest consists simply of a very heavy cylindrical barrel, rifled and chambered for the cartridge to be tested, and fitted with a breech action but no stock. A V-shaped trough of steel is mounted on a heavy concrete base, and is fitted with elevating and deflection screws. In preparing to use this rest, a telescope is first laid in the trough, and by means of the adjusting screws, the cross-hairs of the telescope are brought on the target. The adjusting screws are clamped so that the rest cannot move, the telescope is removed, and the heavy cylindrical barrel is laid in the trough. Obviously, this cylindrical barrel lying in the bottom of the V-shaped trough will point in the same direction as the telescope pointed when the adjustments were made, which is toward the target. The barrel is now loaded and fired. It will recoil and jump when the explosion takes place, but it will not move the rest, because it is simply lying in the trough, and is not fastened to the rest in any way. Every time the gun is loaded and put back in the rest it will always point in precisely the same direction as before, and thus firing it in this way will give a perfect test of the accuracy. Such Mann rests are constantly used in testing pistol ammunition; but these tests tell us the accuracy of the ammunition only, and do not help when we want to know whether or not revolver No. 1 or revolver No. 2 is the more accurate.

However, the Mann Rest has been adapted in a way to testing weapons; some years ago Col. Roy D. Jones of the Springfield Revolver club arranged a pair of steel rings to slip over the barrel of single shot target pistols and clamp in place, thus allowing the pistol to be tested in the V-shaped trough of the Mann Rest. This gave a very satisfactory test with .22 caliber arms, but did not work satisfactorily with the larger caliber guns, because they jump so violently when fired that the rings could not be clamped firmly enough to hold them from moving. No doubt, however, something of this kind could be worked out if enough effort were expended on it. Mr. A. L. Woodworth, of Springfield Armory devised a testing device for rifles which gives the best results of any method yet devised for testing the accuracy of individual rifles. The Woodworth Cradle, as it is called, consists of two large rings or cylinders of steel supporting a cradle into which a rifle can be clamped. The entire cradle, rifle and all is then laid in the Mann V-trough and fired. Undoubtedly a Woodworth Cradle could be made for revolvers.

For many years machine rests of one kind or another have been used in arms factories and in ballistic laboratories for holding revolvers for testing velocity, etc., where it is necessary that the gun point nearly in the same direction for each shot. These give much better accuracy than the average off-hand shot can secure, and are very satisfactory for making certain that the shot will strike a chronograph wire or screen, but they are not capable of showing the real accuracy of a revolver on a test.

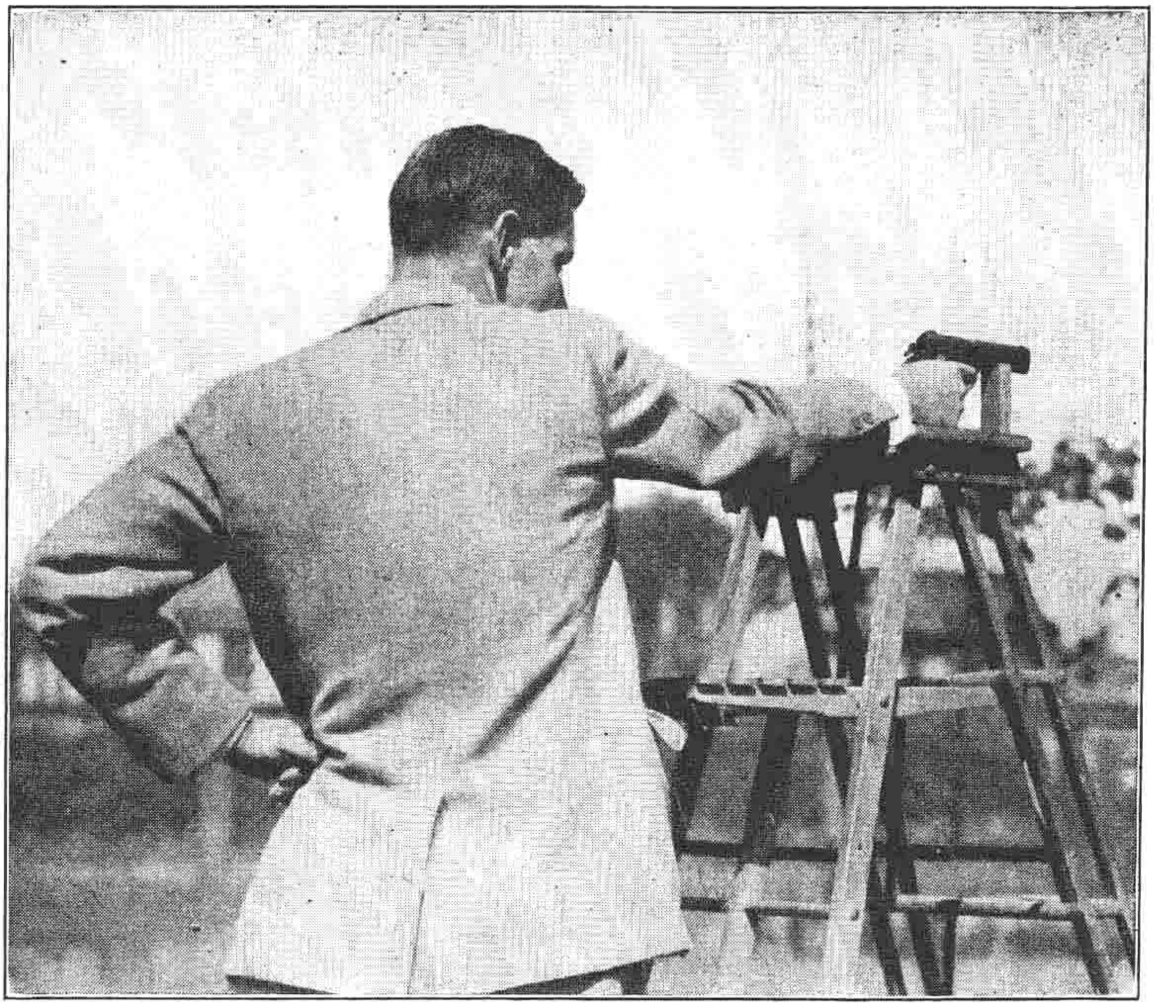
Another method of testing is to use what is called the Six Point Rest. A V-shaped support is provided for the muzzle of the gun; another similar one for the breech end of the barrel; a stop to come against the trigger guard, to limit the distance the gun is pushed forward in the Vs; and a stop to rest against one side of the butt to limit the position of the gun in a vertical plane. The gun is placed with the muzzle resting in the forward V, and the breech end of the barrel resting in the other. Then it is pushed forward until the trigger guard comes in contact with its stop, and is rotated until the handle comes against its stop. It is then fired. It will jump, but as it is not fastened in any way to the rest, the jump of the gun will not disturb the position of the rest. The gun is then loaded and again placed in the rest, when it will come to exactly the same position and will be pointing the same as before. It will be seen that there are six points of contact between the gun and the rest; namely, the two sides of the crotch which holds the muzzle; the two sides of the crotch which holds the



The "Six Point" rest and manner in which pistol is fitted into it.

breech; the stop for the front of the trigger guard; and the stop against which the stock rests when the gun is rotated as far as it can go.

Such a rest is very easily improvised by cutting a V-shaped notch in a piece of wood, and nailing it on a heavy wooden bench to act as a muzzle support; using a similar piece for a breech support; using the edge of the bench at the stop for the trigger guard; and nailing a block of wood on the edge of the bench to serve as a stop against rotation. As there are no adjustments on this arrangement, the procedure in testing for groups with it is to first find where the shots are going by firing a trial shot, then hang the target where the first shot went and try for the group.



The "receiver-and-forearm" rest as used at Springfield Armory in targeting the .45 Automatic Pistols for National Match work.

At the big revolver factories, expert shots are employed who target the guns by shooting them off-hand to test the sighting, and then fire from a forearm rest to test the size of the group. The shooter stands or is seated behind a slanting table of the right height and slope so that when the gun is grasped with both hands and the forearms are rested on the table, the sights are at the right of the eyes. This gives a very firm support, which eliminates much of the personal error that otherwise might enter.

At Springfield Armory the thousands of Automatic Pistols specially selected for use at the National Matches are targeted by the use of an improvised rest made by taking a step-ladder of the right height to support the forearm of the targeter, and fastening to the top of it a piece of board with a V-shaped notch cut in it. This piece of board is adjustable up and down, and can be clamped in any position by means of a thumb-screw. This notched board is adjusted so that when the targeter's forearm rests on top of the step-ladder, the V-shaped notch will support the pistol by the receiver just forward of the trigger guard. This "receiver and forearm rest" is perhaps the most satisfactory method of testing heavy caliber revolvers for accuracy.

With .22 caliber arms, it is another story. They have such a light recoil that they can be successfully clamped in a fixed rest so that they will not change position during a string of shots. Harrington & Richardson use a machine rest to target every one of their target pistols and revolvers at the regulation distance of 20 yards. Every gun made is targeted as a part of the process of manufacture. Smith & Wesson have also developed an excellent fixed rest for their .22 caliber arms, which has enabled a constant check to be kept on the accuracy of their product, and has greatly facilitated studies of the effects of changes in construction designed to produce further advances in accuracy and to enable the arms to handle most efficiently all the various new types of .22 caliber ammunition that are constantly making their appearance.

Sights

Every gun must be provided with some accurate way of determining when it is correctly pointed at the target. This is accomplished by the use of "sights," consisting of a blade or post of some kind on the front end of the barrel, and a notch or groove or a peep-hole on the breech end. By holding the gun so that the post on the muzzle appears to be in line with the target when it is viewed through the notch or peep-hole on the breech end, the gun is lined up so that a hit will be made when the trigger is pulled.

The post or blade on the muzzle is the "front sight," and the notch or peep-hole on the breech is the "rear sight," and these two sights must be positioned in such a relation to the axis of the bore that when the sights point at the target, the axis of the bore points in such a direction that a bullet leaving the barrel will hit the target. The bore of the rifle when the gun is sighted points nearly at the target, but not exactly at it; for when the gun is fired, it jumps, and moreover, the bullet travels in a curve, and not in a straight line, so that when the gun is fired, the bullet never goes exactly where the barrel points.

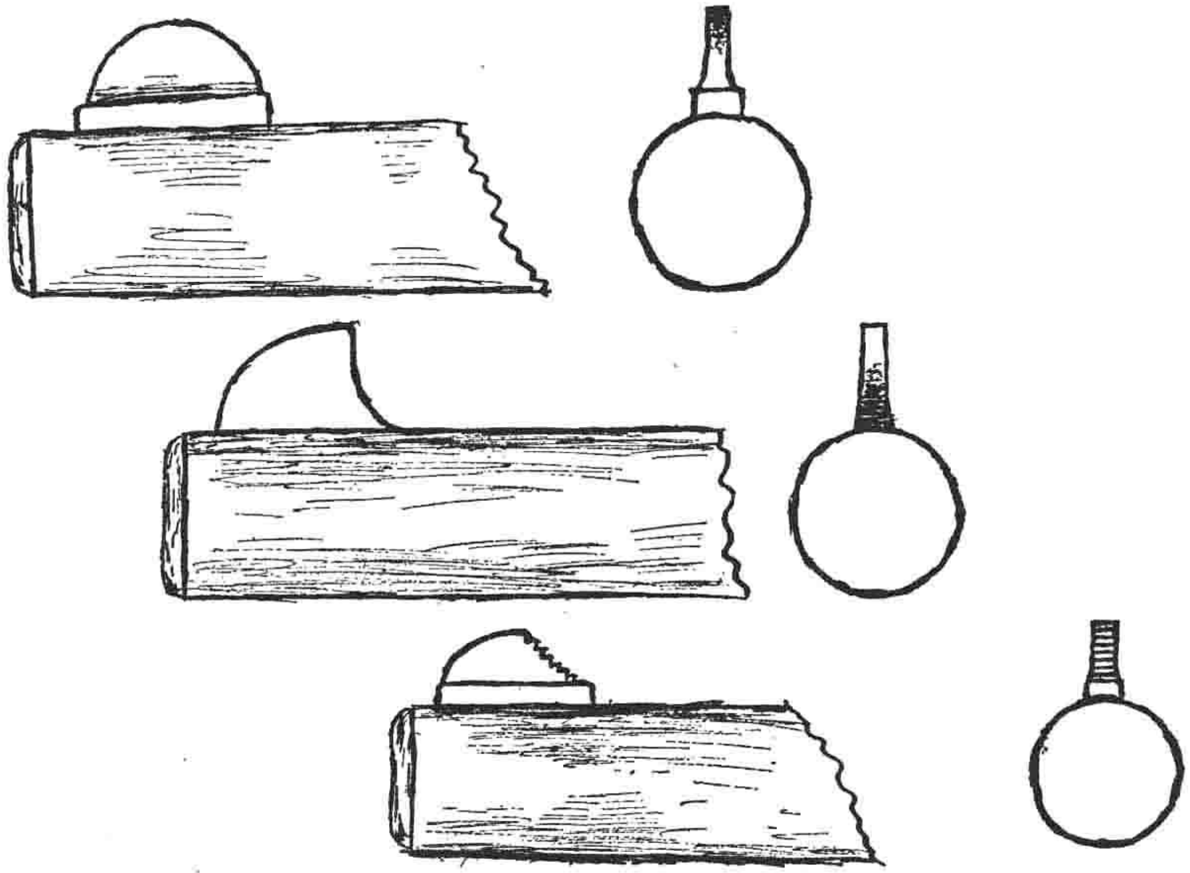
The problem of sighting guns is complicated by the fact that as soon as a bullet leaves the muzzle it starts to drop. For example, the .45 Colt bullet drops about 7 inches at 50 yards, 30 inches at 100 yards, and 131 inches at 200 yards. The Springfield rifle bullet drops about 40 feet at 1000 yards. Thus if you fired directly at a man 1000 yards off, the bullet would go 40 feet below him.

To enable the shooter to hit accurately at different ranges and under different conditions, the sights on most rifles are made so that their position with relation to the line of the bore can be changed to meet different ranges, different powder charges, different wind conditions, etc.

With pistols and revolvers, where the range is always very short, it is not absolutely necessary to have adjustable sights, and most pocket or military type pistols and revolvers have what is called "fixed sights;" that is, the sights are lined up at the factory for the average shooter and average ranges, and are made a part of the frame and barrel of the gun. Usually the front sight is a vertical blade on top of the barrel near the muzzle, and the rear sight is a notch or groove in the frame. It is very important that the sights, and particularly the front sight, shall be shaped so that they cannot catch in the pocket or holster. For this reason, the front sight on most pocket revolvers is rounded, so that it looks like a half circle of metal sticking up on top of the barrel. This rounded form has the disadvantage that the light from the sky strikes it at different points under the different conditions, and thus makes it very difficult sometimes to see the sight clearly, or to tell just where the top of it is. To overcome this, some fixed front sights, such as those on the Colt New Service Revolver, are made with the back edge of the sight vertical, instead of rounded. This makes sighting easier, but has the disadvantage of being more likely to catch; but as this large military type gun is usually carried in a stiff holster, no trouble from this source is anticipated. The smaller Colt guns are all made with rounded sights.

An improved form of fixed front sight that will not catch, and at the same time does not suffer from irregular reflections is the sloping sight with corrugated rear surface used on the Mauser and Luger Pistols, and lately, on the Colt Ace and Woodsman automatics. The rear sight on the fixed sight model revolvers is simply a notch in the frame above the cylinder; but in late years even this simple notch has been greatly improved by making it practically square in outline, and by cutting into the frame just at the rear end of the notch, so that the edges of the notch are outlined sharply, and it looks the same in various kinds of light.

Sights differ considerably in the shape of the outline seen when sighting, and there has been a gradual style trend in this matter, the same as in many other things, so that while most target sights made some years ago were of one kind, those made today are all of a distinctly different and newer design. The earliest sights were of what is sometimes called the "barleycorn" type, consisting of a V rear notch, with a front sight which is wide at the base, and tapers to a narrow upper portion with a flat top.



Different types of fixed front sight. Top, rounded sight as used on pocket models and on S. & W. Military. Middle, sight on Colt New Service Revolver. Bottom, slanting sight with corrugated rear face, as used on Colt Ace and Sport Model Woodsman. A similar sight is also used on the Luger and Mauser pistols.

Next there was "Paine" sight, named for Chevalier Ira A. Paine, a professional marksman who became very prominent about 1880. The front sight, when viewed from the rear, appears to be a little ball, or bead, supported on a stem, and the rear sight is a

U shaped notch. For many years practically no other sight was used by expert revolver shots, but finally a change in style came with the introduction of the "Patridge" sight, so called because it was first described in a letter to *Shooting and Fishing* by Mr. E. E. Patridge, dated January 13, 1898.

The Patridge sight is now almost universally used on target pistols and revolvers. It consists of a rectangular blade front sight with a vertical back surface, used in conjunction with a perfectly square or rectangular notch as a rear sight. In sighting, the top of the front sight blade is even with the top of the rear sight bar, and the blade is in the middle of the notch.

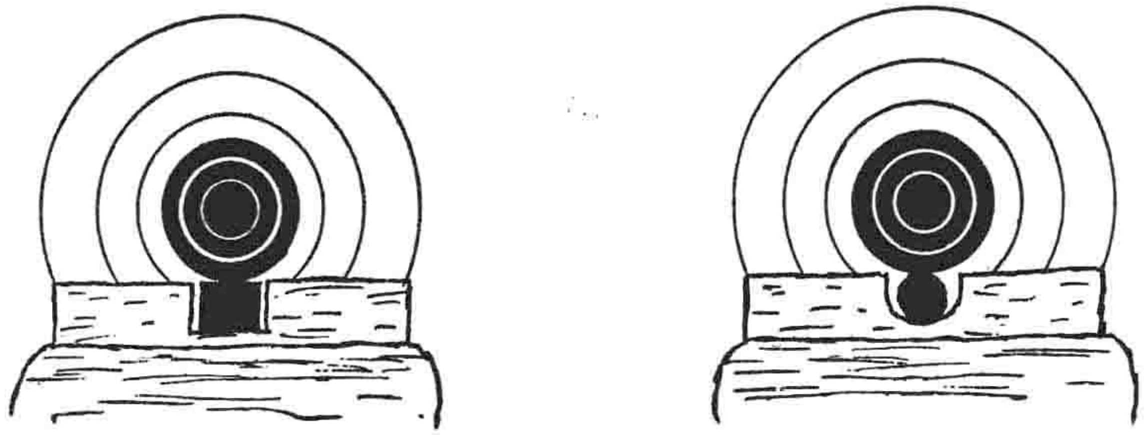
In late years the tendency has been toward wider sights. Formerly the idea was that fine sighting required fine and dainty sights; but this view has been proven by experience to be erroneous, for very small or fine sights are difficult to see, and the resultant eyestrain neutralizes all the advantages that they are supposed to give. Large sights, that can be plainly seen are easy on the eyes, and allow the sights to be seen plainly with a resultant increase in accuracy.

The present day Patridge sights on the best target arms range from .05 inch to ⅛ inch in width, with 1/10 inch as the preferred size. The width of the rear sight notch depends on the barrel length, on how far the gun is held from the eye, and on the lighting conditions. The notch should be just wide enough to allow a plainly visible strip of light to be seen along both sides of the front sight. As the lighting of most indoor ranges illuminates the targets only, and as the brilliantly illuminated target has a tendency to form a glaring white background, a narrower strip of white is needed for indoor shooting than would be ideal for outdoor work. As an indication of the usual dimensions of the rear sight notch for good results, I might say that with a distance of 7¼ inches between sights, I find that with a 1/10 inch front sight a rear notch .09 wide is excellent for indoor work.

It is quite easy to experiment with Patridge sights of different sizes, for these sights are of such a form that anyone with a file and a few old scraps of metal can shape up a set in a few minutes. It is well, however, in doing work of this kind to remember that the best results are obtained if the shape of the front sight blade and of the rear sight notch are such that stray reflections are eliminated as far as possible. To prevent reflections from the top and sides of the front sight, the top should slope down toward the front, so that the tallest part is at the rear; and to prevent reflections from the sides, the sides should slope inward toward the front, so that the rear face is the widest part. As an added refinement, the rear surface of the front sight may be undercut, so that any backward reflection of light will be thrown down and will not reach the shooter's eyes.

In like manner, the rear sight notch should be shaped so that it is wider and deeper at the front than at the back, so that only a thin edge is actually used to sight with, thus giving the sharpest possible outline.

While sights of this kind are excellent for target practice, where the outline of the rear sight notch is sharply outlined against the white background of the target paper, they are not so good for use in the woods, for in certain lights it will be found that the sights cannot be seen at all, and even when the front sight can be seen plainly, the outlines of the rear sight notch will not be clear. For satisfaction in work of this kind, it is absolutely necessary to use a light colored bead, or a light colored facing of some kind on the front sight. A flat faced ivory bead is very satisfactory, but a gold bead is even more easily seen in all kinds of light.



PATRIDGE PAINE

The left, or Patridge sight is the favorite for target practice. The bead or Paine sight, formerly used almost exclusively for target shooting is still the best type for hunting and shooting in the woods. Besides showing the shape of these two kinds of sights, the author's sketch also shows the proper six-o'clock hold for target shooting.

A bead that is rounded on the rear face is more easily seen than is a flat bead, but it will have high lights on one side or the other, depending on the direction from which the light comes, and it will tend to "shoot away from the light;" that is to say that if, for example, the light comes from the right, the gun will shoot further to the left than it should, and vice versa. This is because the part of the sight that is toward the light will have a bright spot or highlight on it, and this bright point is all that is seen when aiming.

This gives the same effect as if the front sight had been moved in that direction.

The best shape of sight for use in the woods is a fairly small bead, with a rather large U-shaped rear notch. The bead should not be too large, otherwise it will cover up the aiming mark entirely in many cases, for small objects such as the head of a snake, for example, are much smaller than a bullseye. It takes a round bead to get properly onto such a mark, because in game shooting the gun should be sighted to hold right on the mark; the practice of holding under is correct for the target range, where the sights can be more clearly defined against the white paper than against the bullseye, but it is not the best system for the woods, where everything is a dark color, and there is no chance to outline the sights against a white background. The sight must be placed just where the bullet is to go, because most of the time the mark will be moving off, and the sights must be held just in front of its head; and in the limited time for getting off the shot it is difficult to hold under and off at the same time. The ideal sight for this work would be a small round bead, with a center insert of gold or some bright material.

The rear sight for either a hunting handgun, or one for quick shooting should have a U notch of ample size; most of them are too small. There should be plenty of room around the bead when the arm is extended for sighting. In a poor light it is very hard to pick up the rear bead if it fits too closely to the sides of the rear notch. The Patridge sight with a rear notch that is right for use on the indoor target range is entirely too close to be of any use either in hunting or for quick defensive shooting. It is too hard to find, or to "notch" quickly, and you have to wobble the muzzle about to see where it is, as it may be right in the rear notch and yet block out so much light that it cannot be seen. The front sight also would be entirely too broad for hunting use, as it would block out too much of the mark; most of the time it would cover or block it out entirely. For both hunting and defensive work the shooter wants to be able to see around his sights and seem to see *through* them. The idea of blocking out all of the mark except what sticks up above the front sight is wrong except for bullseye or target work.

One way of improving a target sight so that it will work better in the woods, is to sink a circle of gold colored metal into the rear face of the ordinary Patridge front sight. This gives a sight having a gold bead which is perfectly flat and flush with the surface. It can be seen very well in most lights, and because it is flat, it does not shoot away from the light. When the sights are used on the indoor target range, the gold spot is on the dark side of the front sight and cannot be seen. For outdoor target work on the range, the front sight can be smoked, when the gold bead will disappear until the layer of smoke is rubbed off. This type of sight is described by the name of the "Call" sight, and is furnished regularly on many outdoorsman's revolvers, and can usually be obtained as optional equipment when desired.

Perhaps the most satisfactory sight for exclusive use outdoors is the King Ramp Red Bead Reflector sight. This is a front sight of a special red composition resembling ivory, which is mounted on a ramp containing a non-corrosive mirror of chromium which throws the light of the sky on the sight in such a manner as to make the red bead show up plainly under almost all conditions.

Peep Sights

By far the most successful iron sight for use on rifles is what is known as the peep sight. The rear sight, which is placed as close as possible to the eye, is a disc with a hole in it. In sighting, the shooter merely looks through this hole, and places the front sight on the target. He does not have to pay any attention to the rear sight; in fact, he does not even see it. It is a peculiarity of the human eye that in looking through a small hole the eye naturally centers itself in the middle of the aperture with great accuracy.

One of the greatest difficulties connected with sighting a weapon with open sights is the inability of the eye to focus sharply on three points at different distances, namely, the rear sight, the front sight, and the target. The eye can see sharply only one of these three things at a time; the other two will always be more or less blurred. In the actual operation of aiming, the eye is constantly changing its focus, so that first one, then the other of these three objects is clear. These changes take place with great rapidity, so that the mind is not conscious of them. The shooter sees all three points indifferently well because he is constantly shifting his attention, and at the same time his eyesight, from one point to the other. With a young man, whose eyes have excellent accommodation, this is fairly easy, but with older men, whose eyes have lost their flexibility, the matter of sighting becomes a very difficult problem. Many of the older rifle shooters have been forced to use telescopic or peep sights for this reason.

The use of a peep sight solves the rifleman's problem because he can neglect the rear sight entirely and concentrate on the front sight and the target. True, he now has to focus his eyes on two points at different distances, but this is not so hard, because both points are fairly distant from his eye. The closer to the eye one has to look, the harder it is. The focus of the eye is just the same for an object 50 feet away or a mile away; but it is tremendously different for an object a foot away or two feet away. It is when objects are placed within about a foot or two of the eye that they require a violent change in the curvature of the eyeball to enable them to be seen well. If the eye is focussed on a rear sight 18 inches from the eye, the bullseye will appear badly blurred; but if the eye is focussed on a front sight four feet from the eye, the bullseye will appear only slightly blurred; the eye is nearly right for it, too.

Because it is so hard to get clear definition of an object close to the eye, it is not possible to use an open rear sight satisfactorily if it is placed closer than about 15 inches from the eye; two feet is better. This is the reason why most open rear sights on rifles are placed well up toward the middle of the barrel. The further the sight is placed from the eye, the easier it is to see clearly. Moving the rear sight forward reduces the distance between the rear sight and the front sight, and gives a short sight radius; but the loss of sight radius is more than made up by the additional clearness of the rear sight.

With peep sights, on the other hand, the rear sight should be as close to the eye as possible, and if it is placed close enough, the eye will naturally look through the exact center of the hole, and the rear sight will not be seen. The eye can then concentrate on the front sight and the bullseye.

Besides removing the troublesome job of focusing on an object close to the eye, the peep sight helps in another way. It acts like a diaphragm stop on a camera, and sharpens up everything that the eye sees when looking through it. The lens of the eye has to collect all the divergent rays from every object seen, and draw them together into an image of what is seen. When looking through a very small opening, there are fewer divergent rays allowed to reach the eye, so that the eye has an easier task of collecting them and composing them into a picture.

This can be illustrated by drawing the curtains of a room, or putting a piece of paper over the windows so as to darken the room. Then if a small hole is punched in the curtain or paper, so as to let in a very fine ray of light, a picture of everything that is in view outside will be thrown on the opposite wall, or on a piece of paper held behind the hole. This is what is called a pin-hole camera. A metal disc or piece of black paper with a pin-hole in it can be used instead of a lens in a camera, and excellent pictures can be taken. The peep sight acts the same way. It throws a sharp image of everything in front of it into the eye, and very little accommodation is required in order to see well.

From what has been said about the peep sight, it would seem that such a sight would be ideal for pistol shooting, but actually we find that peep sights have never been used to amount to anything on pistols or revolvers. In fact, the rules of the U. S. Revolver Association prohibited peep sights up until a year or so ago, when the rule was changed to allow them in some of the matches. The reason for this state of affairs is found very simply in the fact that when used on a pistol or revolver, peep sights are so far from the eye that most of their advantages disappear. It is possible to use a peep sight on a revolver or target pistol, but there seems to be very little advantage in it, Personally, I much prefer good open sights of the Patridge type.

Adjustable Sights and How to Use Them

Ordinarily the front sight consists merely of a rounded blade of metal fixed to the top of the barrel, and the rear sight consists simply of a notch or groove cut into the top of the frame. This is the case on most military or pocket revolvers. Such sights are called "fixed sights," and their location with respect to the axis of the bore is very carefully determined at the factory so that the gun will shoot into the bullseye with the average shot using the average ammunition. However, there are variations between different shooters in the method of sighting, the method of holding, etc., as well as in the kind of ammunition used, so that it quite frequently happens that a revolver with fixed sights will shoot too high or too low, or to one side or the other, with certain marksmen.

In order to allow such a condition to be remedied when it occurs, most target revolvers and pistols have sights which are arranged so that their position can be altered at will, usually by means of screws. They are called "adjustable sights," and are highly desirable, for they permit the sights to be changed to suit the individual marksman, or to compensate for differences in ammunition.

If the rear sight is moved to the right, the shot group on the target will also move to the right. In the same way, if the rear sight is raised or lowered, the group on the target will follow suit, and move in the same direction. On the contrary, the group moves in the opposite direction to any movement of the front sight.

On the Colt target pistols and revolvers, and the H. & R. Sportsman revolvers, the front sight is adjustable for elevation, and the rear sight is adjustable for deflection. Thus, if the gun shoots too low, the front sight is *lowered*. If it shoots too far to the right, the rear sight is moved to the left. The user must remember to move the rear sight in the direction that he wants the group to move, and to move the front sight opposite to the direction of the desired change.

On the other target pistols with adjustable sights, the front sight is fixed, and all of the changes are made on the rear sight, which can be moved up and down with one set of screws, and sideways with another set. The more desirable system is to have all the adjustments on the rear sight, which avoids the possible confusion incident to having to move the front sight in the opposite direction to that of the rear sight for any given correction.

In finding how much sights should be corrected, with either fixed or adjustable sights, always go by the results of the average location of a group of shots. Any one single shot may be affected by poor sighting, poor trigger pull, some inaccuracy in the cartridge, or one of several things. Usually if two shots are fired, they will be some distance apart. Obviously, it would be wrong to use either of them in this case. In the same way, if only one shot were fired, and the sights were judged by the result, the next shot might have gone in quite a different place without any sight change.

Instead of judging by the results of one shot, at least five, and preferably ten or more should be fired, and then the center of the group should be taken as the point to which the gun is shooting. To find the center of a group of shots, measure the vertical distance of each shot from the bottom of the target. Add all these vertical measurements, and divide by the number of shots. This will be the average vertical distance of the shots from the bottom. Draw a line across the target at this height from the bottom edge. The center will then lie somewhere on this line. Now measure the horizontal distance of each shot from the right hand edge of the target, add all these measurements, and divide by the number of shots, which will give the average distance of all shots from the right hand edge. Going in this far from the edge, draw a vertical line. The center of the group is where this line crosses the horizontal line already drawn.

Of course, in finding the center in this way, it is not at all necessary to use the edges of the target to measure from. If you prefer, you may draw a horizontal line across the target near the shot group, and use this as a base line to measure from; and you can draw a vertical line in any convenient place and use it instead of the right hand edge of the target.

A method of determining the approximate center of the group which is much quicker, but not quite as accurate, is to provide a sheet of celluloid or tracing paper with concentric scoring rings drawn on it like those on the target. Lay this transparent sheet over the group and shift it around until the highest score is obtained when the rings on the transparent sheet are used to score by. The center of the ten ring on the scoring sheet will indicate the practical center of the group. A hole should be provided in the center of the scoring sheet through which the center can be marked onto the target.

Having found the center of the group by one of these methods, take a foot rule and measure the amount that this center is above or below the center of the bullseye on the target, and also how much to the right or left it is. This will show one how many inches the group must be moved in both elevation and deflection by adjusting the sights. After this adjustment is made, the shooter should find his group centered on the bullseye when he aims at the bottom of the black.

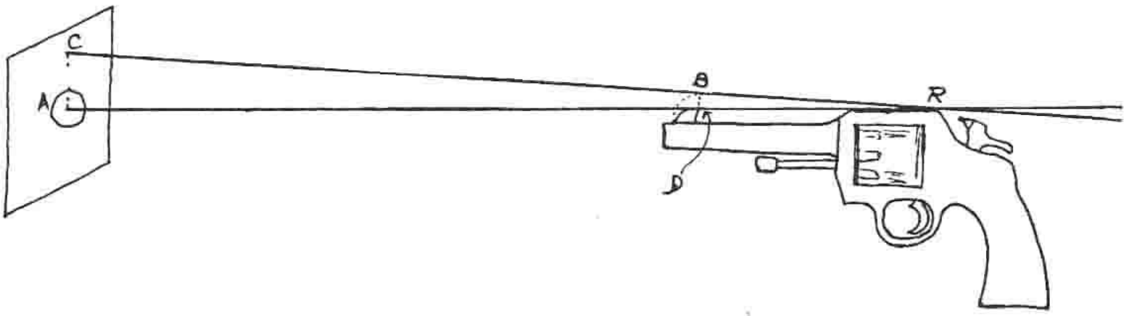
The user of any target gun will naturally want to know how much he must move the adjustable sights on his gun to make a given change on the target. If, for example, he is shooting an inch too low, must he move the adjusting screw one turn, a half turn, or what? The amount that he must turn his sight adjusting screw to move his sight group an inch on the target depends on the following things:

1. The amount a turn of the screw actually moves the sight.
2. The distance between the front and rear sights; in other words, the "sight radius."
3. The distance from the gun to the target.

When all these things are known, the distance that the group will move on the target for each turn or half turn of the adjusting screw can be calculated by the rule of similar triangles, for the movement of the group on the target bears the same relation to the movement of the sight, in inches, as the range, in inches, bears to the sight radius in inches. This will be made clear by reference to the accompanying diagram.

The rule is, to find the amount that the shot group will move on the target for one turn of the adjusting screw, divide the range in inches by the sight radius, and multiply the result by the movement of the sight in inches corresponding to the turn of the screw.

For example, suppose that we are shooting an 8 inch barrel Camp Perry Model Pistol at 20 yards, and our group has gone one inch too far to the right. How much must we move the windage adjusting screws to bring the group to center? This gun has a 7½ inch sight radius, and the adjusting screws, acting directly on the rear sight, have 50 threads per inch, so that they move the sight .02 inch per turn. According to the rule given above, the range must be in inches, so we multiply our 20 yards by 36 and obtain 720 inches. Then dividing this by 7½ we obtain 97. Multiplying this in turn by the movement of the sight in inches for one turn of the screw, or .02, gives 1.94 inches that one turn of the screw will move the group on the target. But we want to move it only an inch, or approximately half this much, so that a half turn of the screw will be correct. We therefore slack off the left screw ½ turn, then tighten up the right screw. This will move the group .97 inch, which is very close to the figure desired.



Effect of changing the height of front sight. With the high front sight the shot would drop too low and gun would have to be sighted at "C" to hit bull's-eye. The amount of sight to be removed may be calculated by similar triangles, thus BD is to AC as RD is to RA.

Unfortunately, there is no universal rule as to the amount that the adjusting screws will move the group, as every manufacturer makes several different models with different barrel lengths, which use the same sight screws, and moreover, the screws do not always work directly on the sights. Usually they work through a leverage of some sort, so that the movement of the screw is multiplied by the time it reaches the sights.

An approximate rule, which is sufficiently close for all practical purposes, is that one turn of the adjusting screw will move the shot group one inch for every ten yards of range, except for the front sight adjustment on Colt guns, which moves the group three times this amount.

For those who are interested in the exact figures, the following tabulations covering sight radius, movement of the sights, and movement of the group on the target per turn of the screw have been prepared.

Sight Radius

A rough rule is that the sight radius is approximately ½ inch less than the barrel length on single shot pistols, and one inch greater than the barrel length on target revolvers. There are some exceptions, however, as will be seen.

Name of gun	*Barrel length*	*Sight radius*
Colt Ace	5¼ inches	6.3 inches
" Camp Perry Model	8	7½
" Camp Perry Model	10	9½
" Woodsman	6½	9⅜
" Woodsman Sport Model	4½	7⅜
" Police Positive Target	6	6.76
" Officer's Model	6	7.05
" Officer's Model	7½	8.55
" Shooting Master	6	6.90
" New Service Target	7½	8.60
Smith & Wesson .22-32	6	7.05
" " Reg. Police Tar.	6	7.05
" " K-22	6	7.15
" " Mil. & Pol. Tar.	6	7.15
" " .38/44	6½	7.65
" " .44 Target	6½	7.65
" " Straight Line	10	9.25
" " Perfected Model	10	10.
Harrington & Richardson		
U. S. R. A. Model	7	6.2
" " " "	8	7.2
" " " "	10	9.2
" " Sportsman	6	7.25
" " New Defender	2	3.37
Iver Johnson Sealed Eight	6	7.11
Webley Single Shot	10	9.

MOVEMENT OF SIGHTS IN INCHES PER TURN OF ADJUSTING SCREW

	Elevation adjustment		***Windage adjustment***	
	Threads per inch on screw	***Movement of sight for 1 turn of screw***	***Threads per inch on screw***	***Movement of sight for 1 turn of screw***
Colt Ace	50	.02	50	.02
" Woodsman	50	.07*	50	.02
" Camp Perry Model	50	.07*	50	.02
" Target Revolvers	50	.07*	50	.02
H. & R. U.S.R.S. Model	80	.023	80	.02
" Sportsman	80	.01*	80	.0125
" New Defender	80	.01*	80	.0125
S. & W. Perfected Model	64	.05	48	.021
" Straight Line	40	.027	40	.025
" .22-32 Revolver	48	.029	48	.021
" Regulation Police Target	48	.029	48	.021

	Elevation adjustment		*Windage adjustment*	
	Threads per inch on screw	*Movement of sight for 1 turn of screw*	*Threads per inch on screw*	*Movement of sight for 1 turn of screw*
S. & W. Model K, .38 & .22	44	.026	48	.021
" 38/44 & .44 Target	44	.026	48	.021
" .357 Magnum	44	.026	48	.021

*Elevation adjustment moves the front sight.

MOVEMENT IN INCHES OF SHOT GROUP ON TARGET AT TEN YARDS RANGE FOR 1 TURN OF ADJUSTING SCREW

Name of gun	*Barrel length*	*Change in elevation for turn of screw*	*Change in deflection for 1 turn of screw*
Colt Ace Pistol	5¼ inches	1.14 inches	1.14 inches
" Camp Perry Model	8	3.3	.96
" " " "	10	2.6	.75
" Woodsman	6½	2.7	.77
" " Sport Model	4½	..	1.00
" Police Positive Target	6	3.7	1.06
" Officer's Model	6	3.6	1.02
" " "	7½	2.9	.83
" Shooting Master	6	3.6	1.04
" New Service Target	7½	2.9	.83
Harrington & Richardson U. S. R. A. Model	7	1.33	1.15
" " "	8	1.15	1.00
" " "	10	.9	.78
" " Sportsman	6	.50	.62
" " N. Defender	2	1.0	1.30
Smith & Wesson Perfected Model	10	1.8	.75
" " Straight Line	10	1.05	.98
" " .22-32 Revolver	6	1.47	1.06
" " Regulation Police Target	6	1.47	1.06
" " Model K, .38 & .22	6	1.31	1.05
" " .38/44 & .44 Target	6½	1.22	.97
" " .357 Magnum	8½	.97	.78

Multiply these figures by 2 for 20 yard results; by 2½ for 25 yards, and by 5 for 50 yards. For finer changes, use half or quarter turns of the adjusting screw.

Sight Corrections on Fixed Sight Models

As mentioned above, most military and pocket type pistols and revolvers have fixed sights which cannot be adjusted to correct the location of the shot group in case the gun fails to shoot to the point of aim. Guns of this kind are sighted at the factory to shoot correctly for the average user, and in most cases will do very satisfactory work without any changes; but occasionally a fixed sight gun will be encountered that will not shoot anywhere near the aiming point.

In this case, the usual remedy is to aim to one side or the other, or high or low, as the case requires, a sufficient amount to make the shots go where they are wanted. Good shooting can be done in this way, but it is obvious that it is not as easy or convenient as to have the sights adjusted so that the shooter can aim directly at what he wants to hit. For this reason most skilled shots who have to use a gun of this kind for any length of time will want to change the sights in some way, even though they are not made to be adjusted.

The easiest defect to remedy is that of shooting too low, for all that has to be done is to file off the top of the front sight, and this will raise the group on the target. If, on the other hand, the gun shoots too high, it is sometimes possible to file off the top of the rear sight. This can be done in the case of guns like the Colt .45 Caliber Automatic pistol, where the rear sight is a separate piece. However, it is not possible on most revolvers, in which the rear sight consists of a notch or groove in the top of the frame of the gun. In this case, it is necessary to devise some means of raising the height of the front sight. Some times this can be done by peening or stretching the front sight by hammering it, so as to make it thinner and higher. Or a piece of metal may be brazed or soldered on top of it, and then filed down to the right height. If the owner is mechanically inclined, and has the tools available, it is usually easy to cut off the upper part of the front sight blade and slot the front sight base for a new blade which can be made as high as desirable, and then pinned in position.

If the gun shoots to one side or the other, the trouble can be overcome by driving the rear sight to one side or the other in the case of the .45 Automatic and other guns with rear sights which fit into a slot in the frame; but in the case of the ordinary revolver, in which the rear sight is formed in the top of the frame, this is not possible, and all changes must be made on the front sight. If the gun shoots to the right, the front sight must be moved to the right to correct the trouble; or if the gun shoots to the left, the front sight must be moved to the left. This change in position of the front sight can be accomplished either by bending the front sight to one side or the other, as the case requires, or by turning the barrel slightly in the frame. To turn the barrel, first make a clamp to hold it. This is accomplished by taking a block of oak wood about two inches square, and boring a hole in it. The hole should be of the same diameter as the outside of the barrel as nearly as is convenient. Then saw the block lengthwise through the axis of the hole. By placing one half of the block on one side of the barrel and the other on the opposite side, and then clamping the block firmly in a heavy vise, the barrel will be prevented from turning. The cylinder and crane should be removed, and a stout flat stick inserted through the cylinder opening in the frame will enable enough leverage to be exerted to move the frame with relation to the barrel.

This is possible because the barrel is screwed into the frame; of course a motion in one direction will tend to tighten the barrel in its seat, that is, will screw it tighter; while the opposite motion will loosen it. Usually the amount of motion necessary to correct the sighting is so slight that it can be obtained even if it means screwing the barrel in even more tightly; and if on the other hand, the correction is in the direction of loosening the barrel, the motion is not great enough to produce any noticeable loosening of the barrel.

This system of correcting the sights by rotating the barrel cannot be accomplished with the Smith & Wesson guns, because they have a lug under the barrel which is accurately lined up to latch the front end of the ejector rod, in order to maintain the accuracy of this position, the barrel is pinned so that it cannot be turned.

In the Colt guns, the rifling is left handed, so that the reaction of the bullet in taking the rifling tends to turn the barrel to the right. This makes it necessary to use a left hand thread on the breech end of the barrel where it fits into the frame, in order to prevent a tendency of the barrel to unscrew from the action of spinning the bullet. Thus if the gun shoots too far to the right, the sight correction by turning the barrel requires the barrel to be screwed more tightly into the frame; on the other hand, to correct a gun that shoots too far to the left requires the partial unscrewing of the barrel.

While fixed sights can be altered as described above to correct the sighting, it will be realized that the process is a rather difficult one, and once the change is made, it is very hard to go back to the original condition if a mistake has been made and the change was not needed after all. For this reason, no such changes should be made until a sufficient amount of shooting had been done to make it absolutely certain that a change is needed. Very often, in using a gun with adjustable sights, a change will seem to be needed, and will be made, and then in a few days another change back to the first sight setting will be required. Of course, with adjustable sights, this is a matter of no importance; changes can be made as desired. On the other hand, with fixed sights, it would be rather discouraging to file off the front sight because the gun is shooting too low, and then in a few days find that it is shooting too high. These changes in grouping do occur, however. They may be due to a change in the lighting conditions; a change in the hold or the sighting; a change from indoor to outdoor shooting or vice versa; a change in range from 20 to 50 yards, or from a variety of other causes. The moral of this is, go very slowly in making permanent changes in the sighting of your gun. Be sure that you have shot it enough to know just what to expect in the future. Of course, if a gun shoots badly off in a given direction every time you use it, a change is needed; but it is best to make just part of the change at first, and then use the gun for a while longer before making the rest of the change. In this way you will give yourself time to settle down to the use of the gun. Then when the final change is made, it should be just sufficient to correct the gun for *average* conditions.

If, for example, your gun groups a foot low the first time you use it, and something like a foot low the next few times, it would be safe to make a correction of something like 8 inches at once. It should now group 4 inches low. But maybe by several weeks more of shooting you will find that sometimes it actually groups 1 inch high, sometimes 2 inches low, and again occasionally it groups 3 inches low. Obviously, then, the average is halfway between these extremes of one inch too high and three inches too low. The halfway point is 1 inch low. By changing the sights to bring the group 1 inch higher, we will have done all that we can. We should then expect to find that on some days the center of our group will be as much as two inches high; on these days we must hold a little low to compensate for the error. Again, however, we might shoot under other conditions and find our group centered two inches low. Under most conditions, however, we should probably not be anywhere near these two extremes, but instead, would be very near the center of the target.

Trigger Pull

The ease of shooting with pistols and revolvers is very greatly affected by the amount of force required to pull the trigger. With a heavy trigger pull the muscular contraction required to make the gun go off is such that there is a considerable tendency to cause the bullet to deviate. This fact causes most target shots to favor a very light trigger pull.

The rules of the U. S. R. A. allow a minimum trigger pull of 2½ pounds for revolvers in the "Any Revolver" Match. For single-shot pistols the minimum pull is 2 pounds. For military revolvers and pistols, or pocket revolvers, the minimum trigger pull allowed 3½ pounds. There is also a special match based on the International rules, with no limit on trigger pull.

Revolvers, and especially automatic pistols, are somewhat safer to handle and use with a slightly higher trigger pull, generally between 5 and 6 pounds. This is about the amount of the trigger pull on revolvers and pistols as ordinarily received from the manufacturer. For practical shooting, it is recommended that a fairly heavy trigger pull be maintained.

The character of the trigger pull—that is, its smoothness—is really of more importance than the actual weight. A creepy, grating trigger pull is the very worst kind, and even though the actual force required to pull the trigger may not be excessive, good shooting can not be done with a trigger of this type. What is wanted is a smooth trigger pull, in which the trigger does not move as pressure is applied until finally it gives way all at once with no creeping or sliding at all.

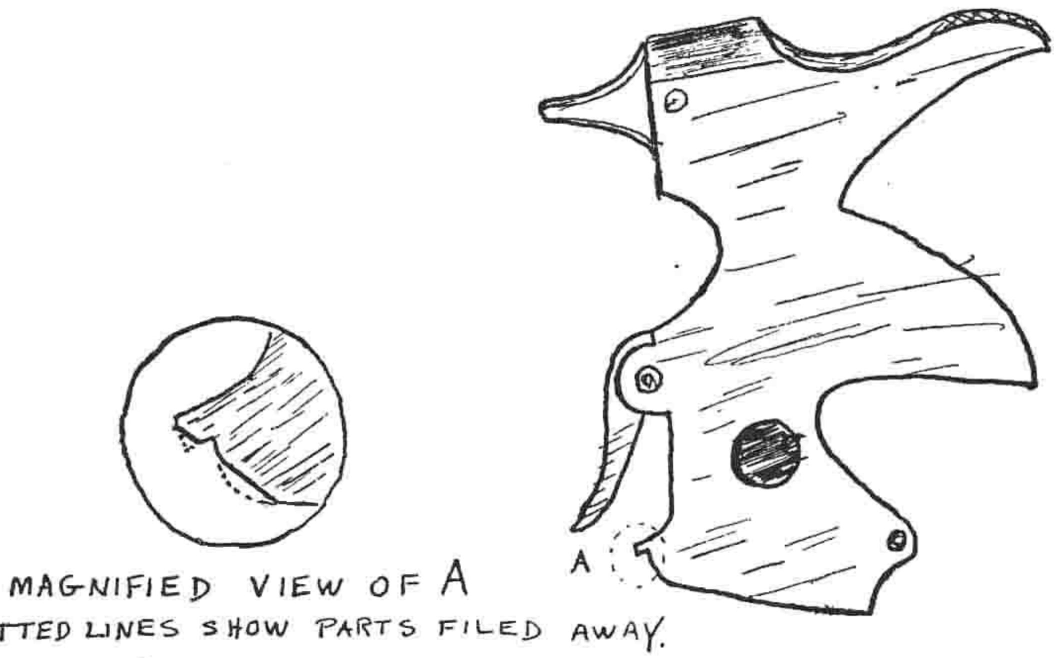
In the matches of the U. S. R. A., or of the N. R. A., trigger pulls are always tested before the match by means of lead weights with a wire hook. In testing the trigger pull, the weight is applied at a point three-eighths of an inch from the end of the trigger, with the barrel held vertical.

Most users of target revolvers and pistols at some time or another want to smooth up their trigger pull or reduce it to a lower figure. In general this is a rather ticklish job and requires a great deal of care and practice to get good results. The character of the pull depends on the character of the rubbing surfaces on the nose of the sear, or the nose of the trigger, and the surface on the notch of the hammer. Another factor which influences the pull is the tension of the trigger or sear spring which is generally the rebound spring in revolvers, and on the strength of the mainspring.

I have frequently known revolver-shots to weaken the mainspring to get a lighter trigger pull. Sometimes they do this by turning out the strain screw on Smith & Wesson revolvers; sometimes by grinding off some of the back of the spring on Colt revolvers. I want to advise strongly against any such procedure because it is wrong in principle and results in a light blow on the primer, which will give hangfires and consequent inaccuracy. It may also give misfires.

One of the large revolver factories wrote to me and said that giving out full information to the public on changing trigger pulls is much like writing a popular treatise on how to perform an operation for appendicitis.

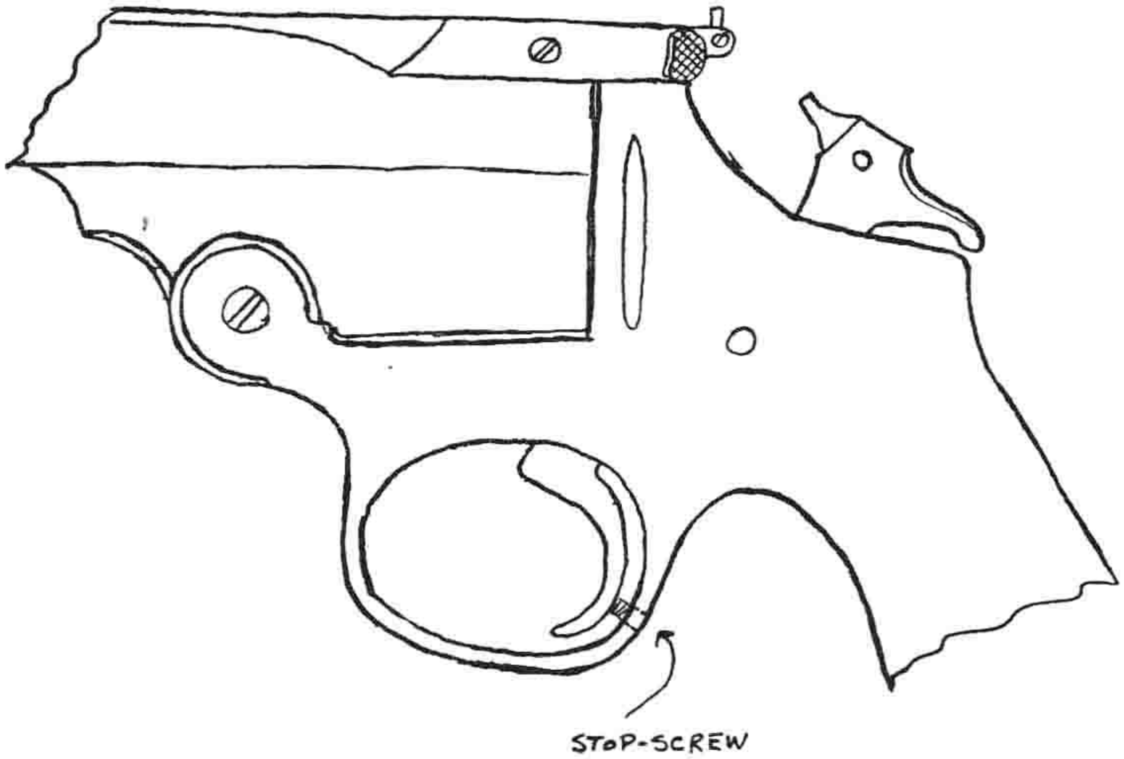
However, the amateur can learn to doctor up trigger pulls quite successfully if he is prepared to study the proposition and possibly spoil a few hammers or triggers before he gets through. The essentials are a couple of small fine oil stones and a watchmaker's glass. The first thing to do is to take off the side plate of your revolver and study the action of the trigger nose in the hammer notch very carefully. Then take out the hammer and trigger and examine the rubbing surfaces very carefully with your glass and you will see where they can be smoothed up. All file marks and roughness should be removed, so that there is a perfectly smooth surface. This will generally greatly improve the pull. Sometimes the point of the trigger is very narrow, and the pull can often be improved by stoning it down until it is somewhat wider, and therefore has more of a bearing, taking care to preserve the angle correctly. Some experts reduce the depth of the hammer notch so that the trigger does not have so far to slide in being pulled out of the notch, but the factories generally advise against touching the hammer. Nevertheless, I have a Colt Officer's model with a very fine pull, and I note that as it came from the factory, the hammer notch had been reduced in depth with a file as per the accompanying sketch.



Sketch of the hammer of the author's .38 Officer's Model revolver, showing how the factory had filed the notch in the hammer to produce a particularly clean, sweet pull. The careful and mechanically experienced shooter may accomplish the same thing, but if it is attempted by the unskilled owner, he may very quickly ruin the hammer.

The factory experts, who make a living by tuning up trigger pulls generally work with a fine file. They have had so many years of experience that they can take just one glance at the hammer and trigger of a gun whose pull is not right, and then know exactly what to do. Often a single stroke with a fine file to reduce the depth of a notch, as described above, will do the trick. This is, of course, quite different from what I have advised above; but there is not one shooter in ten thousand that can have the experience at this work that is the lot of the factory man, and my advice to shooters who want to work on their own trigger pulls is to leave the file alone and stick to the oil stone.

The trigger pull on the .45 Automatic can not safely be reduced below 5 pounds, because if this is done there is danger of the jarring action of the mechanism causing the hammer to slip off the sear and follow the slide down with a resulting misfire. I have known these guns to have their trigger pulls reduced as low as 4 pounds and operate satisfactorily for some time; but just when least expected a malfunction is likely to occur.



Sketch of the author's S. & W. Single Shot Pistol, showing the stop screw fitted into the back of the trigger guard to prevent the trigger from jarring the gun by a sudden backward motion when the hammer is released. This screw was fitted at home, and the whole job required only a few minutes time.

If the trigger pull on the automatic has been reduced to a point where it is uncertain, this fact can often be discovered by a simple test. Be sure that the gun is unloaded; then take out the magazine, so that the slide will close when drawn back and released, and holding back the trigger, draw the slide back and let it snap shut as smartly as possible a number of times. If the hammer goes to half cock, it shows that the trigger pull is too light, and that the jar of closing the slide causes the hammer to fall. If the trigger pull is correct, the hammer will remain cocked until the trigger is released and pulled again.

Many target-shots use a stop to limit the motion of the trigger when it is pulled. The reason for this is obvious. When aiming at a target, the index finger rests on the trigger with a considerable amount of pressure until finally the trigger slips out of the notch. If the trigger moves a considerable distance after it slips out of the notch the resulting motion of the hand may deviate the aim enough to do quite a lot of harm. This motion of the trigger may be checked by wrapping a little adhesive tape around the trigger guard behind the trigger, so that when the trigger is pulled it strikes against this layer of tape. By adding layers, a point can be reached where the trigger can just be pulled enough to disengage from the notch but will move no farther. A neater way to accomplish the same result is to drill a hole in the back of the trigger guard and tap it for a small screw against which the trigger will strike when it is pulled. This screw may then be adjusted until the trigger can just be pulled enough to clear the notch.

Along the same lines is the practice sometimes encountered of placing a springy piece of live rubber behind the trigger. Once I had a pistol with a trigger that was difficult to let off without causing the muzzle of the pistol to dip at the instant of discharge. I blocked the trigger with rubber, and then when I pulled the trigger I felt my finger compressing the rubber more and more until finally there was a click as the hammer fell; but there was no difference in the feel of the trigger at this point, and the muzzle of the gun did not dip. Afterward I found that one of the members of the International Rifle Team of which I was captain had hit on the same device on his .22 caliber rifle.

One of the most annoying things that can happen to a match shooter who has worked on his gun until it has a fine trigger pull just above the minimum weight is to have the trigger or hammer wear just enough to make the gun fail to hold the weight when weighing in before some important match. Often this may be due simply to gradual wear; but more often it is due to the bad habit that some shooters have of absent mindedly grating the trigger and the sear notch over each other. Very often a shooter will pick up a gun and cock it, then pull the trigger just enough to ease the hammer down with his thumb, and as he talks, he will repeat this nervous mannerism, all the time grating the point of the trigger over the notch in the hammer and ruining the trigger pull more quickly than can be imagined. If you are going to let the hammer down, first hold the hammer well back with the thumb, then pull the trigger well back and hold it there while lowering the hammer. Then the trigger and sear notch cannot come in contact, and no harm will be done. Just grating the sear notch and trigger point once will do more harm to the surfaces than any amount of snapping empty or dry shooting.

If you ever do get caught so that your favorite pistol will not hold the weight by a very small margin, try in some way to strengthen the trigger spring. In the Smith & Wesson revolvers this can be accomplished by taking out the rebound block and placing behind the spring a thin disc of steel, brass, or fiber, sawed off the end of a rod of the right diameter, such as a piece of drill rod. Some modern guns, such as the Harrington & Richardson U.S.R.A. Model Single Shot Pistol, have a screw which compresses the trigger spring. Turning in this screw, which on the H. & R. is located just forward of the trigger guard, will make the trigger hold more weight.

Some of the older models of revolver, such as the Colt Single Action Army, have a half cock notch, and this, together with the rebound notch used on some modern guns is one of the worst enemies of fine trigger pulls. If the hammer slips out from under the thumb in cocking the gun, the half cock notch will strike the point of the trigger, usually with resultant damage to the trigger pull, which may even be so severe as to cause the trigger point or the notch to be broken. Then there is always the danger that when the trigger pull is very light, the half cock notch may rub or catch on the point of the trigger when they pass as the hammer falls. One remedy that is often used with the Single Action Army is to file off the half cock notch.

The modern Colt and Smith & Wesson revolvers and target pistols do not have a half cock notch or rebound notch. The rebounding hammer in these guns is operated by a sliding block or a lever under the heel of the hammer, operated by the trigger. When the trigger is released after the discharge of the arm, it moves forward under the action of the trigger spring, and it moves the rebound block forward under the heel of the hammer, locking the hammer in place.

However, the Harrington & Richardson U.S.R.A. Model does have a rebound notch on the hammer, and in the early models some trouble was experienced from the striking of the rebound notch of the hammer on the full cock point of the trigger. In the later models of this gun the difficulty has been entirely eliminated by a very clever design of the trigger, which uses a separate point for the rebound. This point is placed further from the trigger pivot than the full cock point, so that the half cock notch on the hammer never even approaches the full cock point.

Lock Time

Something that has a very intimate relation with the question of trigger pulls is what is called "lock time," or, in other words, the length of time it takes the lock-work of the gun to function, or the interval from the instant the trigger is pulled until the hammer actually strikes the primer of the cartridge.

Obviously, in fine target shooting, a very important factor is the time it takes for the bullet to leave the gun after the trigger is pulled. If the gun is waving around in the air, even one thousandth of a second may make a difference, because the gun may have moved considerably after the trigger was pulled and before the bullet starts on its way.

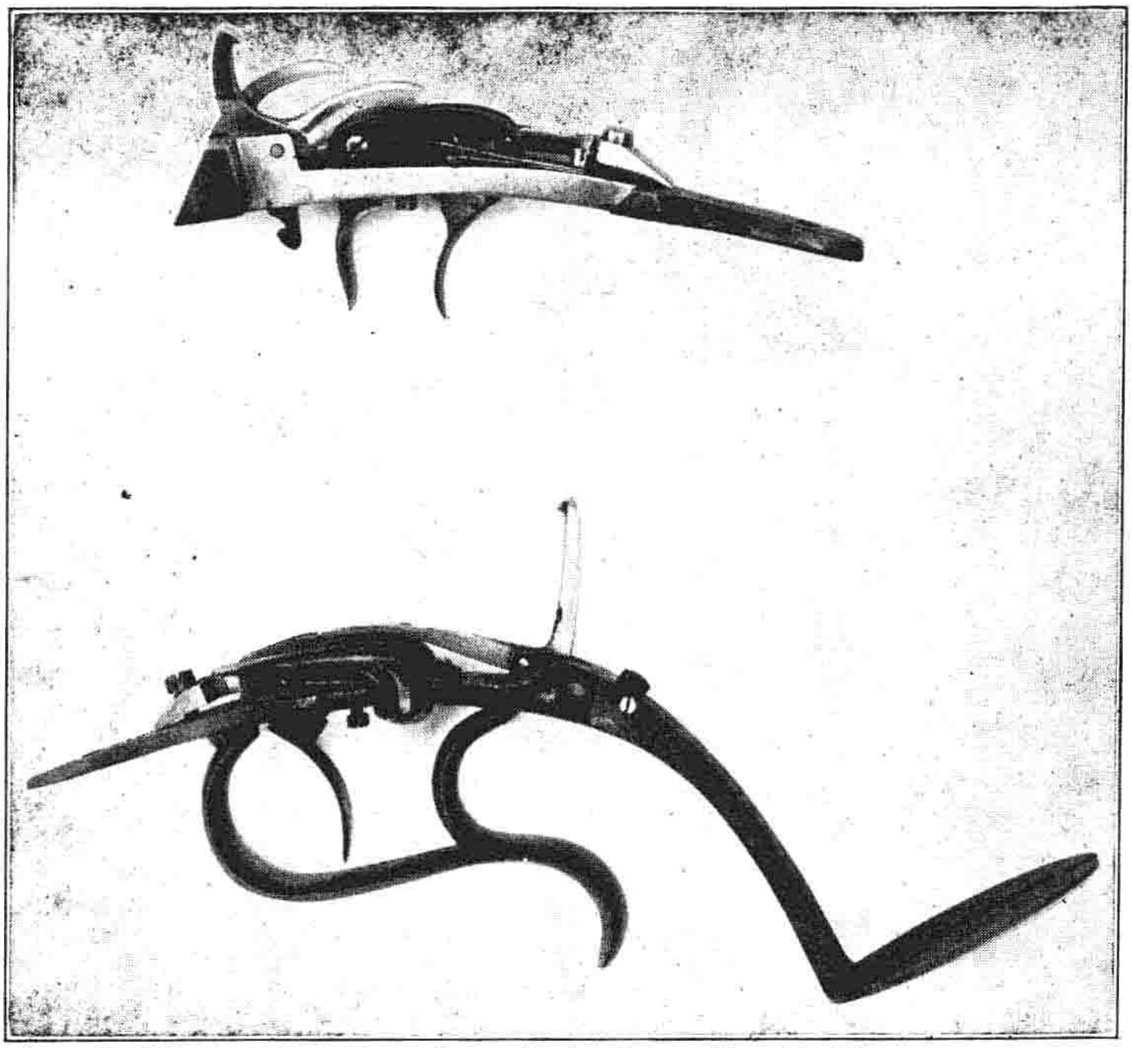
To cut down the lock time, the hammer travel must be short, and the mainspring must be very strong. This strong mainspring in turn causes a heavy pressure between the point of the trigger and the notch in the hammer, with resultant heavy trigger pull. This heavy pressure between the metal surfaces also has a tendency to cause rapid wear.

In modern target pistols with a very short hammer fall and a heavy mainspring, the designer has had to meet some very difficult problems in making a pull that will be light enough and at the same time will wear well. In the best designed guns this problem has been solved by wide surfaces on trigger and hammer notch, to reduce the unit pressure on the metal; by special steels and heat treatments to give great strength and durability; and fine workmanship and high polish on the surfaces involved.

A comparison between pistols made some ten or twelve years ago and those being sold today will reveal a marked change in the direction of a shorter hammer throw and heavier spring. For example, the latest Colt Camp Perry Model Target Pistols have a much shorter hammer throw and a much faster lock time than those made only a few years ago.

Set Triggers

In the International Matches there is no limitation as to trigger pull; it may be as light or as heavy as the fancy of the shooter directs. Consequently, most of the arms used in these matches are arranged for an extremely light trigger pull, often called a "hair trigger." This ultra-light trigger pull is obtained by means of a mechanism known as a "set trigger." This is an arrangement by means of which the trigger can be cocked or "set" so that it will discharge the piece with the lightest touch. Generally there are two triggers, one in front of the other. If the gun is cocked, and the front trigger is pulled, it will discharge the piece, the same as will an ordinary trigger; but if the rear trigger is pulled, it does not discharge the piece, but "sets" the front trigger so that the slightest touch will cause the discharge of the gun. There are not always two triggers. Sometimes there is a lever on the side of the gun that will set the trigger, and again, there may be only one trigger, which may be set by pushing it forward.



Top: Double set trigger from the author's Stotzer Free Pistol.
Bottom: Set trigger from the author's Buchel Free Pistol. In this model, the mechanism is "set" by depressing a side lever, instead of by pulling back the rear trigger, as is usual with double set triggers.

The set trigger mechanism contains a striker or hammer of its own, which is cocked by the action of setting. Then, when the front trigger is pulled, this striker is released, and it flies up and strikes the regular sear, knocking it from its notch, and discharging the arm.

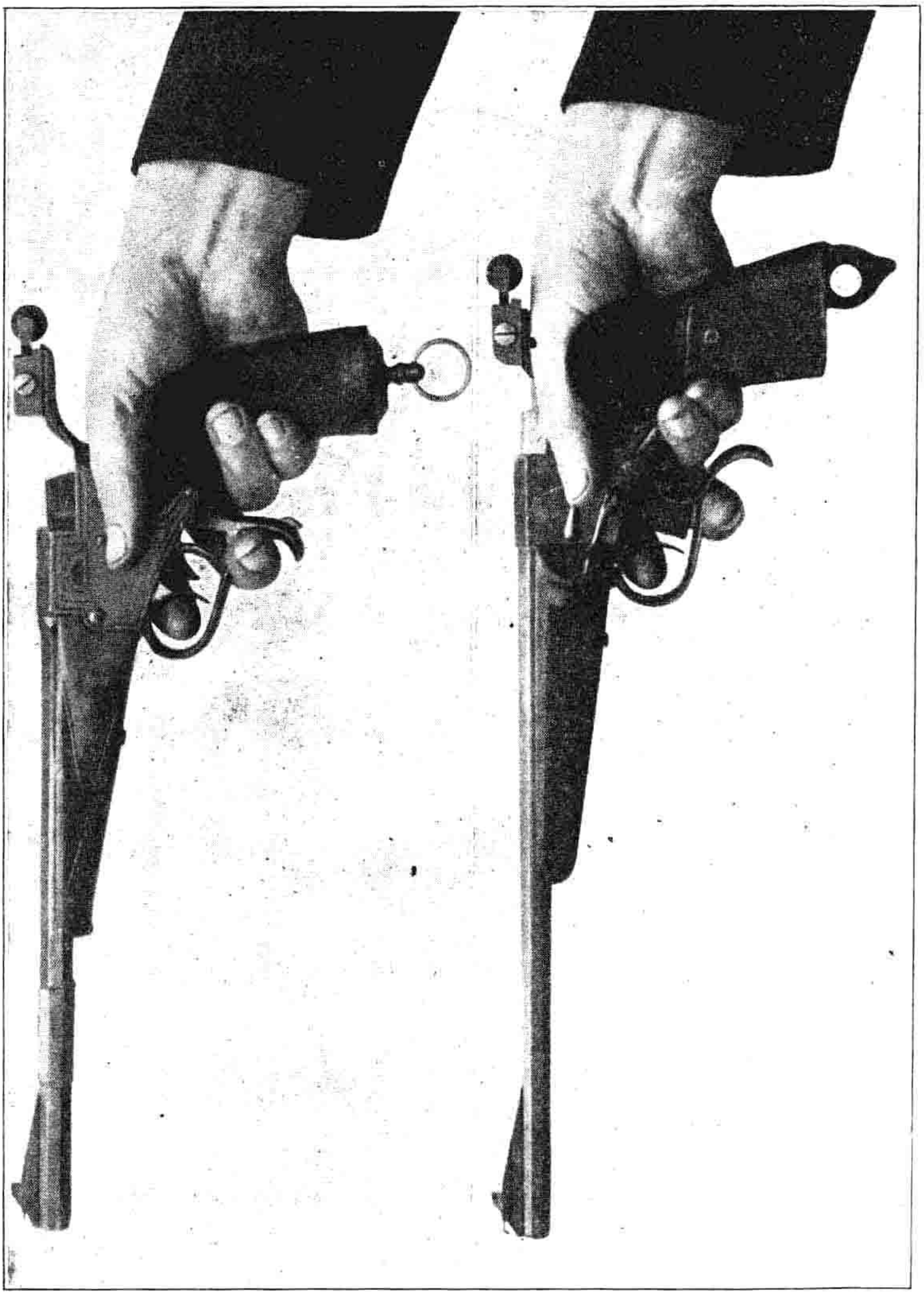
The pull of a set trigger is lighter than the pull of a regular trigger can be made, because the spring that cocks the striker in the set trigger is lighter than the regular mainspring of the gun, and there is a relatively light pressure between the set trigger and its own sear. Then, again, in the finer set triggers, the sear releases a lever, which in turn releases another lever, which in turn releases the striker of the set trigger. Each lever reduces the pressure, so that the pressure on the last notch, which is released when the trigger is touched, is very light indeed. Some fine Swiss and German set triggers have as many as five levers, and the pull is so light that the gun can easily be discharged by blowing on the front trigger after it is set.

While the set trigger gives a very light trigger pull, it does not improve the lock time. In fact, it is often very much slower than a plain trigger. When the plain trigger is pulled, the hammer starts to fall at once, but on the contrary, when the set trigger is pulled, the various levers must move before the striker can get started; and the striker must knock the sear out of engagement before the hammer can fall. Some of the European Free Pistols have an extremely short hammer fall and an extremely heavy mainspring, and their owners boast of the fast lock time, not realizing that the short throw and heavy spring no more than compensate for the set trigger delay.

Set triggers are almost always provided with an adjusting screw with which the amount of pressure necessary to discharge the front trigger can be varied to suit the user.

Shooting with a set trigger is quite different from ordinary pistol-shooting and requires a considerable amount of practice in order to excel in it. However, with set triggers it is very easy, after one has learned how to use them, to make much higher scores than can be made with the ordinary trigger. They are, however, quite dangerous to use, as accidental discharges are frequent.

In the International Matches each competitor stands in front of a long bench, and in loading his gun he rests the barrel on this bench or support so that the muzzle points downward toward the ground at an angle of about 45 degrees. Holding the gun in this position, he loads it, closes the breech and sets the trigger. If an accident occurs, so that the set trigger goes off prematurely, it is not charged against the shooter's score provided that the barrel of the gun is resting on the bench. If, however, the gun has been



Two foreign "Free Pistols," showing the manner in which the hand of the user fits into the elaborate stocks with which such weapons are furnished. Left: **Stotzer Perfekt Pistole. Right: Buchel pistol with barrel by Widmer. Note that with the** Buchel pistol, the line of the bore is much lower and more nearly in line with the arm, owing to the fact that the stock is so shaped that the hand and wrist are held **in a higher position. Both models are fitted with set triggers.**

lifted off the bench and the set trigger goes off accidentally, it counts as a zero unless it actually makes a score on the target.

The method of using the set trigger requires a different action with the trigger finger from that of shooting with an ordinary trigger. The shooter does not put his finger in front of the trigger and then squeeze, as is ordinarily done with the plain trigger. Instead, he places the index finger carefully on the edge of the set trigger, pushing a little forward as he does so, so as not by any chance to pull the trigger. In aiming, all he does when he wants to make the gun go off is to relax the muscles slightly, so as to release the forward pressure on the edge of the set trigger, and if the trigger is set very fine this is about all that is needed to make it go off. The motion of the muscles in the hand is almost imperceptible. In fact, as some users express it, you more nearly "wish the trigger off" than pull it. Most good set-trigger pistols have a rest for the index finger which comes right down to the edge of the set trigger and prevents the natural wabbling of the finger from setting it off, as might otherwise occur.

The user of set triggers is cautioned that they are extremely dangerous even in the hands of an experienced user. Accidental discharges are of frequent occurrence whenever set triggers are used. Surprising as it may seem, accidental discharges are seen at the International Matches, where all the users have much experience in handling their arms. This is recognized in the rule above mentioned, which does not count an accidental discharge against the score provided the gun barrel has not left the bench when the discharge occurs.

The lesson in this is that the user should be supercareful to keep the barrel of a gun always pointed at the target after the triggers have been set. If for any reason the shot is not fired the action should be opened before the point of aim is changed, because the slightest jar to the gun may cause it to go off.

Grips

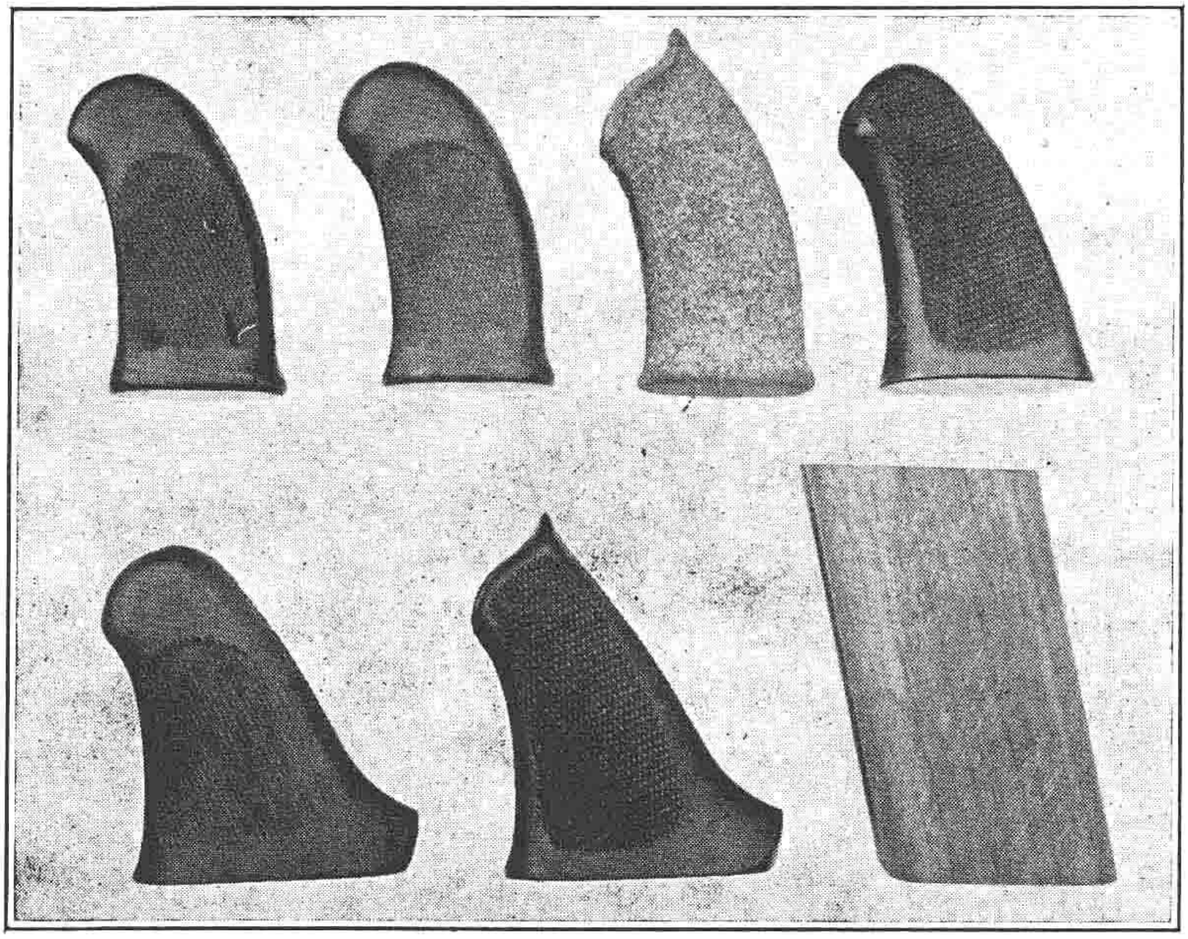
The handle or grip of a revolver is a very important part, and much depends on the shape of it in relation to the shooter's hand. In general, the revolvers of larger caliber have the larger handles, and in the very large calibers the Colt has a slightly larger handle than the Smith & Wesson. The old revolvers of thirty or forty years ago had more comfortable handles than those of the present day. In general these old handles were more rounded at the top than the later ones. On the modern revolver the handle rises straight up at the top, where it joins the frame, and has a sharp edge which tends to cut into the hand on heavy recoil. Also, on the later revolvers the space behind the trigger guard is narrower from front to back and longer from top to bottom than it was in the old-style guns, and the result is a very much poorer fit. The extreme comfort and excellence of its grip is the one reason why the old Single Action Colt still persists in popularity. In those days many other revolvers besides the Colt were made with similar grips, and these old guns are very comfortable to hold, even the smaller calibers.

The handle of the ordinary revolver is really very poor, and it is too bad that a conscientious effort is not made to intelligently design a grip which will give the greatest comfort and satisfaction in using the gun. It is interesting to note that the modern British revolvers, such as the Webley & Scott, have a much more comfortable grip than any modern American large caliber revolver.

One of the worst features of the modern revolver handle is the deep and narrow space behind the trigger guard, into which the middle finger must fit. In the human hand, the index finger naturally lies above the middle finger; but in grasping a revolver, the index finger must be brought down onto the same level with the middle finger in order to grasp the trigger. This results in a cramped and awkward position, which it is difficult to retain in rapid fire, as the repeated recoil impulses tend to move the gun about in the hand when it is grasped thus insecurely. In order to overcome as far as possible this difficulty, many shooters fill this space with a block of rubber or wood cut to fit the space and held in place with tire tape, or in some other way. This filler piece has come to be known to revolver shooters as a "gadget."

Recently the necessity for some change in this direction has been recognized by the arms makers. Walter Roper of Harrington & Richardson designed a trigger guard for the U.S.R.A. Pistol and the Sportsman Revolver with a spur of steel extending back so as to bridge over this space. This is a great help. Smith & Wesson make a filler which can be purchased as an extra. It consists of two steel plates which fit between the two grips and the frame. The top front portion of these plates extend forward beyond the grips to the trigger guard, bridging over the space behind the trigger guard. Between the portion of the plates which extends forward of the grips is a piece of rubber as a filler. Then the gunsmith Pachmayr of Los Angeles sells a rubber adapter or filler to fit any gun. It is held in place by two metal clips which slip under the edges of the wooden grips.

Perhaps the hardest men of all to satisfy in the matter of grips are the users of single shot target pistols. Formerly it was quite common for target shots to make their own grips by obtaining from the factory a piece of walnut of ample size milled out to fit over the frame of the gun. They fasten this walnut in place like the handle, and then take hold of it and whittle it down wherever it feels too large, working on it a little at a time until it comes down to size and feels the best possible.



Interchangeable stocks that can be obtained for the H. & R. Pistol and Sportsman Revolver. Top, left, the No. 1 shape. Next, No. 2, which is somewhat fuller, especially near the top. No. 3 has the same shape as No. 2, except that there is an extra projection to keep the hand from slipping too high up on the grip. This particular sample is made of ground cork, moulded to shape. No. 4 is the Frontier Type, standard on the Sportsman Revolver, which gives the gun much the feel of the Old Colt Single Action. Bottom, left, No. 5 or free pistol style. Next, No. 3-5, which has the shape of No. 5 except that it also has the upward projection at the top as in No. 3. For the Single Shot Pistol with 7 or 8 inch barrel the author prefers this shape. Lower right, a rough block of walnut fitted to the gun and provided with a stock screw, intended to be whittled to any shape that suits the fancy of the purchaser.

All this has now been rendered unnecessary by the manner in which the progressive firm of Harrington & Richardson have put the ideas of Walter Roper into practice. On the U.S.R.A. Model Single Shot Pistol and the Sportsman Revolver, five interchangeable grips of different shapes are furnished as options, and in addition, there is a big block of walnut milled out to fit, which can be obtained by the die-hard experimenter who insists on making his own.

The later automatic pistols have better grips than the modern revolvers. One of the most comfortable grips is that on the Luger automatic, and the Colt .22 automatic is very similar. Many of the earlier automatics were faulty, however, in having the grip at too nearly a right angle with the barrel, so that the barrel had a tendency to point down when the gun was held naturally. The best and most comfortable handle on any pocket automatic is that on the .380 Remington Automatic, which unfortunately is no longer manufactured.

This gun was designed by the celebrated arms inventor, J. D. Pedersen, who also designed the Remington pump action shotgun, the Remington trombone action rifles, the Pedersen Device, or Automatic Bolt for the Springfield Rifle, the Pedersen military semi-automatic rifle, and many other arms. In designing this grip Mr. Pedersen made an exhaustive study of the question. He first made a skeleton frame and then tried various different-sized hands around this frame, filling in with modeling clay until in each case the grip was the one best suited for that particular hand. After a large number of such models were made the final grip was designed to be a compromise between all of them in such a manner that it would fit the average hand the best. The curve at the back of the grip which fits over the junction of the thumb and forefinger, and the space in the trigger guard in which the first finger rests, are so proportioned to each other and the barrel that when the gun rests on the two places above mentioned the barrel points directly in line with the first finger.

A rather important item in regard to the handle on revolvers is the material of which it is made. The best material is one which will not slip when the hands are wet with perspiration or greasy. It is generally admitted that walnut makes the best grip, and it should preferably be checked to prevent slipping. Rubber or ivory make fair grips, though they have the disadvantage of becoming slippery when the hands are perspiring. Pearl is good looking, but it is not a desirable material from any other point of view, for it becomes slippery from perspiration, and it breaks easily. It is perhaps the least desirable material of all, but in spite of this, I have a pair of pearl grips for a Banker's special that I like better than I do any other handles for this gun, merely because these pearl grips are particularly well shaped. They are very thin near the bottom, and are well rounded, so that they feel extremely comfortable in the hand. Of course, walnut grips with the same shape would be preferable from a service point of view.

As mentioned above, the walnut grip should be checked to prevent slipping, and on most modern target arms, the trigger and the frame between the grips are usually checkered or grooved.

Sometimes the balance of a target pistol can be improved by filling the insides of the grip with lead or some other heavy material, or by putting a lead plate on the bottom. Still other target-shots like to weight the barrel of their target pistols by fastening steel rods on each side of the top rib. This is of some assistance in shooting in the wind as it prevents the gun from swaying so much. Pieces of ordinary drill rod serve very satisfactorily and can be bound on the gun with tire tape.

Safety Devices

In the construction of the modern revolver and automatic pistol, the makers have used all the ingenuity at their command in order to insure that there will not be an accidental discharge from any cause. In the old days of the simple six-shooter, it was the universal rule to carry the gun with an empty chamber under the hammer, so that if the gun should fall or be struck on the hammer, there would not be any danger of an explosion. Many fatal accidents are directly due to a failure to observe this rule.

With modern arms, conditions are changed considerably. For example, most small automatics are hammerless, so that there is no danger of striking them on the hammer and so causing a discharge; but they must be carried cocked at all times, with a cartridge under the firing pin, and a sharp blow or the dropping on the weapon may jar the sear out of engagement and allow the arm to go off. For this reason, all such arms are fitted with a safety lock operated by the thumb. Then, in addition, there are many hammerless revolvers. They actually do have a hammer, but it is concealed inside the frame. In these guns, the hammer is not cocked until the trigger is pulled, so that they are absolutely safe from discharge by being dropped.

Some automatic pistols and hammerless revolvers have a grip safety; that is, a piece of metal on either the front or the back of the grip, that must be pressed in when the trigger is pulled, in order to release the firing mechanism. The grip safety is always arranged so that it will be pressed in without any conscious effort on the part of the firer when the trigger is pulled; but if the trigger accidentally becomes caught on some object, the gun cannot go off, as the grip safety will not be pressed in unless the hand of the shooter is grasping the handle of the gun in the proper position for pulling the trigger.

In an effort to get away from the necessity of always carrying the chamber under the hammer empty, the later revolvers were designed with what is called the "rebounding lock." When the trigger is pulled the hammer falls all the way; but as soon as the trigger is released a block or lever, operated by a spring, pushes the hammer back a short distance, so that the firing pin no longer touches the primer, and then locks the hammer in that position. This was a step in the right direction; but the rebounding lock is not fully safe because the point of leverage where the hammer is held in a safe position is generally fairly close to the hammer pivot, and any play or looseness or spring of the parts might allow the primer to be struck in case of a heavy blow on the hammer.

Some years ago the Iver-Johnson Company added to their revolvers a safety device widely advertised under the slogan "Hammer the hammer." In this device there is a separate firing pin, which is mounted in the frame back of the primer, and the hammer is cut away so that it can not strike the firing pin. There is a lever attached to the trigger in such a manner that when the trigger is pulled this lever slides up and comes between the hammer and the firing pin, and the blow of the hammer is transmitted through this lever. In this way it is impossible for the cartridge to be struck unless the trigger is actually pulled. Owing to the very high advertising value of this safety device, it was not long before other companies followed suit. The Colt Company put into their revolvers a lever attached to the trigger in such a manner that when the trigger is at rest a block of metal is interposed between the face of the hammer and the frame of the gun in such a way that the firing pin can not strike the cartridge. When the trigger is pulled this block is drawn out of the way. This accomplishes the same result as the Iver-Johnson device and is known as the "Colt Positive Lock." Smith & Wesson have fitted a number of their models with a somewhat similar device, called the "New Patent Safety Hammer Block." This is found on the Regulation Police, on the .32-20, the .38 Military and Police, the .38/44 and the .357 Magnum, but is not found on the .44 Military or the .45 Model 1917. The company considers that owing to the large size of the hammer and rebound block, the second safety is not necessary on these larger guns. Unless the revolver is fitted with the Iver-Johnson "Hammer the hammer" safety, the Colt Positive Lock or the Smith & Wesson New Patent Safety Hammer Block, a cartridge should not be carried under the hammer. Hammerless revolvers, of course, are an exception.

Automatic pistols must be carried with a cartridge in the chamber, and consequently most automatics are fitted with a safety operated by the thumb in order to prevent the possibility of accidental discharge. In some types these safeties merely prevent the trigger from being pulled and offer no insurance to prevent the hammer being jarred off the sear. In other makes the safety actually blocks the firing mechanism, so that it could not be jarred off under any circumstances. It is well in getting an automatic pistol, to investigate this point and get one in which the safety is really safe.

The .45 Army automatic has a firing pin made shorter than the breech block in which it is housed, so that when the hammer is let all the way down on the firing pin the pin does not project through the front of the breech block and can not press the cartridge. The way this gun operates in firing is that normally the firing pin is held to the rear by the firing-pin spring in such a manner that a slight portion of it projects back behind the breech block. When the hammer falls it strikes this projecting portion and drives the firing pin forward with such force that its inertia carries it on until it strikes the primer, though the hammer can not follow it up on account of striking the rear face of the breech block. This safety device was placed on the pistol by the designers to allow the gun to be safely carried loaded with the hammer down. It is quicker and easier to cock the pistol as it is drawn from the holster than it is to fumble for the safety with the thumb.

If the gun is carried with the hammer cocked and with the safety on, the rubbing of the pistol in the holster, especially when riding on horseback, may cause the safety to move enough to make an accident possible. For this reason it is preferable to carry the gun with the hammer down when loaded and in this condition it is absolutely safe from accidental discharge.

Many accidents have occurred with automatic pistols, owing to the fact that the user may consider the gun to be unloaded when the magazine has been removed, while there still remains one cartridge in the chamber. This has led to the incorporation of the "magazine safety" on many modern automatics. On these guns the trigger can not be pulled when the magazine is out of the pistol, thus rendering it impossible to cause an accident by forgetting that there still remains a cartridge in the chamber.

Silencers

The silencer is a device to muffle or eliminate the noise of discharge of a firearm. It consists of a cylinder about an inch in diameter screwed onto the end of the barrel. Inside there are a number of baffle plates, each with a hole in it to allow the passage of the bullet. The gas as it passes through the silencer expands into the space between the baffles, and then gradually escapes with little noise.

The great fault of silencers on high powered rifles is the fact that there are two distinct noises connected with the discharge of a fire arm; one is the noise of the escaping gas, and the other is the noise that the bullet makes as it passes through the air. The silencer will effectively eliminate the noise of the gun, but cannot have any effect on that made by the bullet after it leaves the gun.

It is a peculiarity of the bullet that when it is traveling faster than the velocity of sound in air, about 1080 feet per second, it will make a sharp report whenever it passes any object, such as a telegraph pole or a tree. The silencer has no effect whatever on this noise.

This is easily noticed with a .22 caliber rifle fitted with a silencer. When using low velocity ammunition, the gun will be almost absolutely silent. The velocity of this ammunition is about 900 feet per second, and is below the velocity of sound. On the other hand, if ammunition of the outdoor type, or the high velocity kind, giving 1200 feet per second or more is used, the gun makes almost as much noise with as without the silencer.

An explanation of this characteristic of bullets will often explain puzzling occurrences on the rifle range or elsewhere. For example my son Robert, shooting Marksman cartridges in his model 52 heavy barrel rifle on the small bore range was puzzled by the fact that while most of the time the report of the gun was a rather dull short "Blup" occasionally it would be very much louder; a piercing and long drawn out "Blarp." He applied to me for an explanation, as he was afraid that the ammunition might be bad, though the groups were all excellent. I told him that quite evidently the velocity of this ammunition was just about the velocity of sound. Those bullets that were just below this point, say, 1070 f.s. made no noise, and all that he heard was the escape of the gas from the muzzle. The other occasional loud shots were those with a velocity of say 1090 f.s., where the bullet made a sharp snap each time it passed a fence, a tree, or anything along the range.

In the same way, a .22 caliber rifle with silencer using the Winchester Staynless .22 short cartridge was quiet, and no report at all could be heard. On the other hand, when the .22 short Super X was used, there was the same loud "Blarp" that was heard before.

In detective fiction and on the stage we sometimes hear of silencers on revolvers, but in real life they are never encountered, simply because the silencer is not effective on a revolver. The escape of gas between the barrel and the cylinder makes such a loud noise that even if the muzzle noise is completely eliminated, the report still sounds very much the same.

There is nothing, however, to prevent the fitting of a silencer on single shot pistols, but when this is done, the result is a long clumsy weapon that would be hard to conceal. Silencers have also been used on specially altered .22 automatic pistols such as the Colt Woodsman, and are very effective in reducing the noise.

It is hardly advisable to experiment along this line, however, as in recent years the silencer has rather fallen into disrepute with the legal authorities. The recently enacted Federal Firearms Act of June, 1934, classes silencers or mufflers with machine guns and sawed off shotguns as weapons the possession of which must be reported to the Collector of Customs within 60 days after the passage of the act, and which are subject to rather stringent regulations as to shipment or sale.

Shot Cartridges in Revolvers

Metallic revolver cartridges loaded with shot are sold in all the popular revolver calibers from .22 up to .44/40. The smaller sizes, such as the .22 and the .32 are loaded with No. 10 or 11 shot, and the largest ones with No. 8. They are not very satisfactory, for the plain cylinder bore of the barrel, combined with the rifling, causes the shot to spread in too wide a pattern to be very effective.

Some gunsmiths convert large caliber revolvers for the use of shot cartridges by boring the barrel to a slightly larger diameter nearly to the muzzle, and then reaming the muzzle section to a choke. The following is abbreviated from an interesting article on this subject by Mr. Bud Dalrymple, of Scenic, South Dakota, in the April, 1930, issue of *The American Rifleman.*

"While hunting coyotes for the Government I decided that a fellow needed some kind of a scatter gun to hit the June and July pups, as we often ran them down and shot them from the saddle; and if anyone thinks a coyote pup at high speed is easy to hit from horseback, he had better try it.

"I tried a sawed off shot gun, and while it worked well at first, the horse soon began to object to having that young cannon fired so close to his ears; and thereafter as soon as I got close enough to the coyote pup to raise my gun, the horse decided that he had business in the other direction. As it requires two hands to work the pump gun, and I didn't have three, I sometimes hit the coyote pup and sometimes I hit where he was not.

"I tried shot in a .45 single action Colt revolver with the regular rifled barrel, but the twist in the rifling started the shot to whirling in a circle, and believe me, it was a large circle, too.

"Finally I decided to remove the rifling from that .45 Colt barrel and see what it would or would not do. I didn't have many gun tools along, but I did have a hand brace and a 15/32 inch twist drill; so I removed the barrel from the gun and proceeded to rebore it. I drilled almost the length of the barrel (from breech to muzzle), and then took the drill and honed the point to a longer taper and drilled on to the end of the barrel. This left a little choke. So far so good; but as the drill wasn't intended to bore a nice, smooth hole, nor polish the hole it made, that Colt barrel looked as if a bunch of rat-tail files had been revolving around in it, and I began to wonder if the shot could possibly travel through such a looking hole and not be all worn out. Fishing around in my ammunition tool box I found some emery cloth, and made a wooden rod that would pass through the Colt barrel loosely. Then I cut a slot through the end to fasten and hold a strip of emery cloth. Next I dressed the other end down to a square that would fit in the hand brace chuck, put the Colt barrel in the vise again, and proceeded to polish the inside of that terrible looking barrel. I turned the brace handle around I think, ten thousand times, and the hole in the barrel still looked like a horse radish grater and my arms were getting stiff and sore. So I decided to put the barrel back in the gun and shoot one load of shot through it and see how much shot would get clear through.

"I primed one of the regular .45 Colt shells and put in about seven grains of Ballistite powder. Then I cut some wads from a cardboard box, and with a stick seated four of them on top of the Ballistite powder. Then I took some No. 2 shot out of a twelve gauge shell and put in all the .45 shell would hold, which of course wasn't an eight gauge load. I used a thin cardboard wad over the shot, and with a shell resizing die I put a good heavy crimp on the brass. All was ready now, so I set up a board at 40 feet, the board measuring about 8 x 12″. I could not help wondering if any of the No. 2 shot would hit it; but when I pulled the trigger the board was knocked clear off the rock I had set it on.

"I felt encouraged, and I certainly was surprised to find that a lot of those No. 2 shot had not only hit the board, but that most of them had gone right through it—and it was ⅞″ pine! My arms were not nearly so stiff and sore now after seeing all those No. 2 shot holes in that board; so I took the barrel out of the gun again, and with that patent polishing tool proceeded to shine it up some more, and finally got it so that it looked quite respectable. And anyway a coyote pup wouldn't care whether it shone like a mirror or not and as long as it shot pretty well I was satisfied. This proved to be just the kind of a gun a fellow needed; and once I got up within fifty feet of a running coyote he was just the same as my coyote for I had six loads of shot to throw at him; and besides, I had one free hand to steer that fractious horse the way the coyote decided he wanted to go. And thus the gun was a complete success.

"Since retiring from Government work I have obtained some gun tools and put up a shop, and have converted a lot of Colt revolvers into shot arms. The .44/40 and .45 Single Action Colts make the best guns; and the .38/40 can be rechambered for the .44/40 shell and the barrel bored close enough so that it will shoot a .44 caliber round ball almost as accurately as a rifled barrel. I make the round balls for these guns of pure lead so they will not spoil the choke; and there you have a gun for both ball and shot. I have made several of these shot and ball barrels from the small ends of spoiled rifle barrels, and by using a barrel of caliber less than the revolver to be used, I can bore it close for round ball and shot. I like about a 7½″ barrel on these shot revolvers as that length seems to pattern the shot better than the very short barrels, as a rule. But I have rebored and choked several 5½″ barrels that shot splendidly. For reloading the shells—and they can be reloaded at least fifty or seventy-five times—I remake the regular Ideal or Winchester tools so that they will put a super-crimp on the shot cartridge and also seat the round ball properly.

"DuPont No. 5 Pistol Powder seems to work as well as any in these guns and I am using it largely. I find that one card wad, one thick, felt wad, and one more card is o.k. over the powder. Put in all the shot the shell will then hold, and put a thin card wad over the shot and crimp heavily. For the round ball I put a card and a felt wad over the powder leaving room so that the ball will rest snugly on the powder. Always use a smokeless primer, as the old black powder ones will cause hangfires, misfires and will also weaken the load.

"I forgot to mention that the abrupt shoulders in the revolver cylinder should be tapered off so that they will not cause the shot to jam; and the barrels must be choke bored or they will scatter too much.

"For those who like a double action revolver the Colt New Service makes a nice shot arm. There are many of these large caliber revolvers laid away, rusting out, since the free range and the cowboy gave place to the farms and the farmer; and these guns can be rebored to shoot shot and then are a very handy and useful arm. I have rebored a lot of them for bankers, doctors, policemen and tourists, and as a gun for self-protection they are just the thing as the .44/40 or the .45 can be loaded with sixteen pellets of BB shot, and at short range they will drive through 1¼" pine, and put the entire load in a would-be bad man's working parts. Such guns are much handier than the regular shot gun to carry in the automobile. I carry one in the auto all the time and pick up lots of game with it.

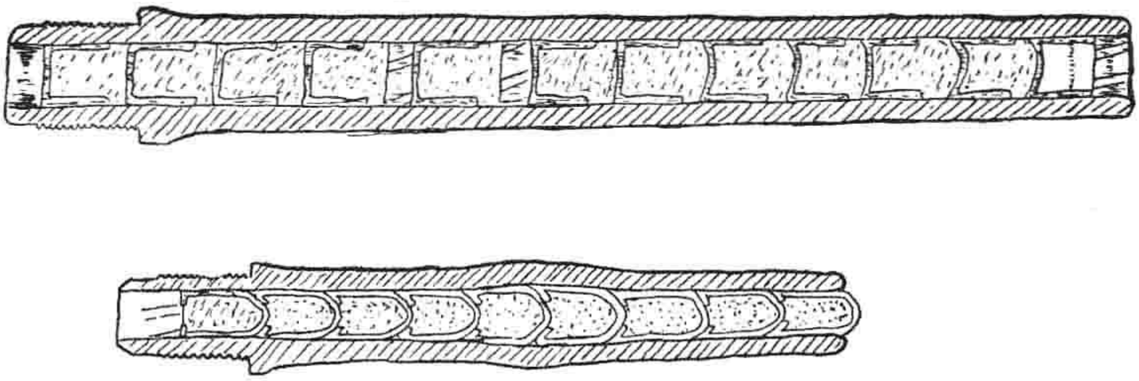
"While I was hunting predatory animals for the Government I needed my rifle on the saddle every day. There were lots of sage chickens, which are very fine eating when young but the young birds hide pretty close in the sage brush; and if a fellow did hit one with a high powered bullet the bird would be ruined. So I carried the Colt shot revolver and got all the small meat we needed for camp. It was real sport, too as I would scare the birds up and shoot them on the fly. I kept track one week of my hits and misses, and out of twenty-two sage chicks that I shot at on the wing, I killed twenty, using No. 8 shot. Dense smokeless powder must be used in these shot cartridges as bulk takes up too much room in the shell. Ballistite, Bull's-eye, Infallible, DuPont No. 5 and Oval are o.k. Be sure not to use too heavy a charge as these are very strong powders."

The above material, all of which is taken from Mr. Dalrymple's article is the best information I have yet seen in print on the subject of shot revolvers. I might add that he has been converting handguns to shoot shot for a number of years.

The Strength of Revolvers and Pistols

Occasionally we will hear of a revolver or a pistol being blown up from the use of an overcharge of powder, or from an obstruction in the barrel. Fortunately these accidents are rare, and moreover, they usually do not result in any injury to the shooter; in this respect revolvers and pistols are much safer than rifles or shotguns.

However, as stated above, accidents occasionally do occur, and every user of a pistol or revolver will no doubt be interested in learning about how and when such troubles occur, and how to avoid them. There are two principal causes of such damage. One, and it is the most usual, is the firing of the gun with an obstruction in the barrel. Sometimes a powder charge in a cartridge may be weakened by the seepage of oil into the cartridge case, or in some other way, so that when the gun is fired, the bullet does not leave the barrel. Then if another shot is fired while the barrel is stopped up, a bulge will be produced, or the barrel may even be split open. This does not injure the user at all.



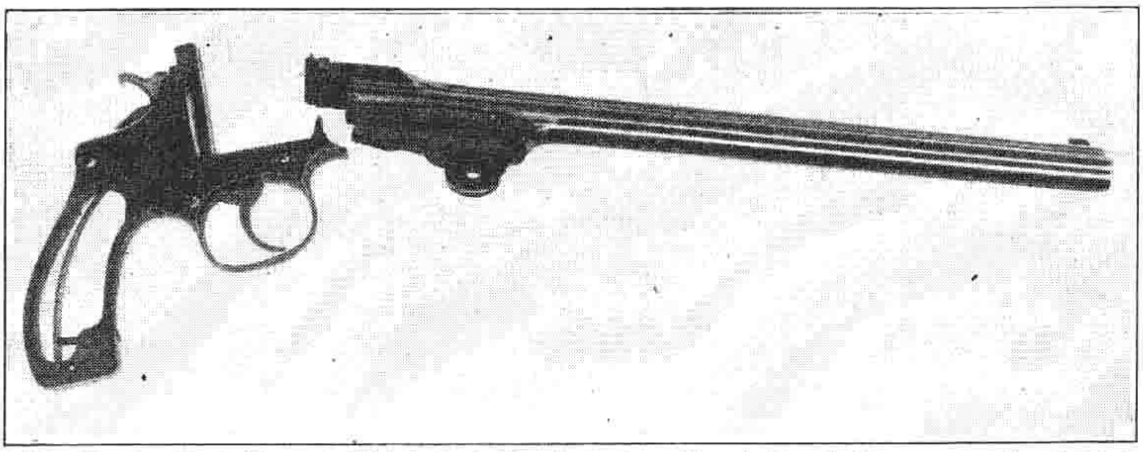
Two revolver barrels which were brought to the author for examination. They were **sawn open as shown, and carefully sketched to show the exact condition. Top: .38** Special barrel with eleven bullets and one jacket lodged in it. Bottom: .32-20 barrel with nine bullets lodged in it.

In large caliber high powered revolvers or pistols, such an accident always bulges the barrel, and often may split it as well. Many .45 Model of 1917 U. S. Army revolvers have been damaged in this way, on account of the deterioration of poor quality wartime ammunition.

In revolvers of small caliber, the barrel usually does not split, though it will generally show a bulge at the point where the obstruction was located in the barrel. I have seen a .38 Special barrel shot absolutely full of bullets from muzzle to breech, without showing even a bulge. This barrel had twelve bullets in it. A .32/20 barrel with nine bullets in it had a large bulge in the middle, which was the location of the first obstruction. The others merely piled up behind it and shoved it forward, until the whole barrel was full. The owner did not know that his barrel was obstructed, and kept on shooting. Both these two guns were brought to me to examine after these occurrences, and I had the barrels sawed open, and then took advantage of the occasion to make a very accurate sketch of the appearance of the barrels, which I include herewith. In both of these cases, as well as in practically every other one that I have ever seen, the bullet which stuck was metal jacketed. A metal jacketed bullet is much harder to force through a barrel than is a lead bullet, and therefore is more likely to stick.

Firing a gun with an obstruction in the barrel will never cause the breech of the gun to burst, unless the obstruction is right against the bullet when the gun is fired. In this case it may prevent the bullet from moving at all, and in this case the pressure in the chamber will rise so suddenly that the chamber may burst.

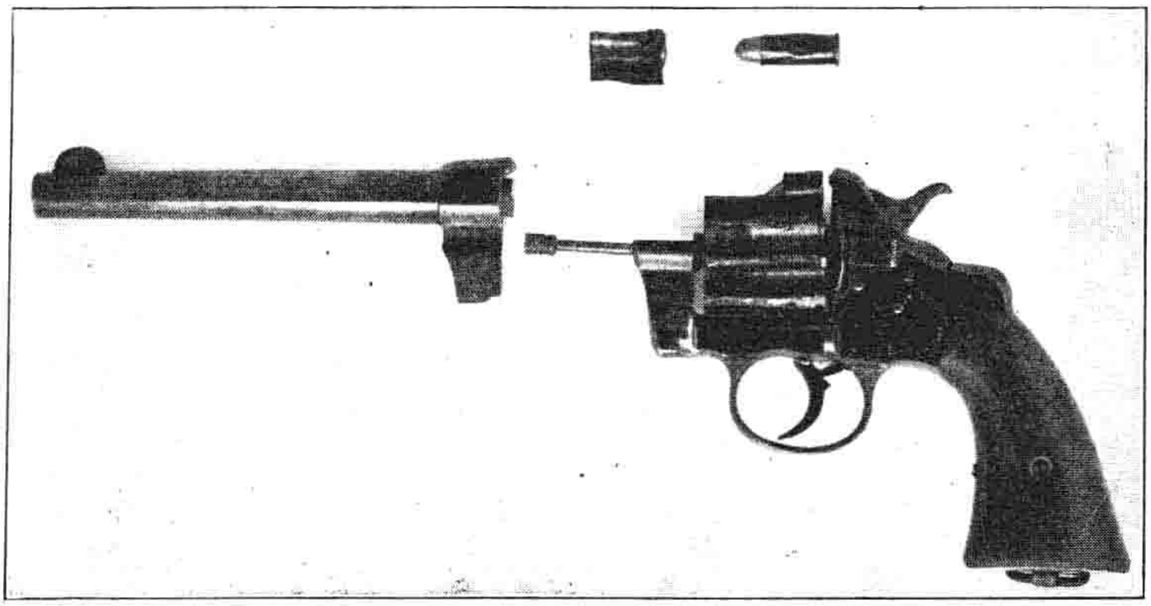
I have before me a 10-inch single-shot pistol that was stolen by a man who did not understand much about firearms. It was a new gun and the barrel was full of cosmoline. He loaded it with a .22 Long Rifle cartridge and fired it. Of course, the cosmoline in the barrel acted as an obstruction. The barrel split open along the bottom near the breech and blew away not only the lug on one side of the hinge, but also part of the frame, thereby wrecking the whole gun. It is amazing to think that this much power can be obtained in a .22-caliber cartridge.



This Single Shot Target Pistol had the barrel split at the bottom near the breech. and the hinge of the frame broken as shown by being fired while the barrel was filled with cosmoline. The damage was caused by a .22 Long Rifle Cartridge loaded with Lesmok powder. The cartridge was not of the Hi-Speed or high velocity type, but was of the ordinary "Outdoor" type so popular for target practice.

Smokeless powder may either burn, explode, or detonate. It is a composition something like celluloid, and if it is ignited in small quantities in the open air, it burns something like celluloid does. On the other hand, if it is ignited in a confined space, as in the chamber of a gun, the heat and gas generated by the burning of the first part that is ignited cannot escape, and this intense heat and pressure will make the remaining portion of the powder burn more quickly. The smaller the space in the cartridge, and the more nearly it is filled with powder, the more quickly will the powder burn. In this case the burning is so rapid that it is called *exploding*. When a cartridge is fired, the powder explodes.

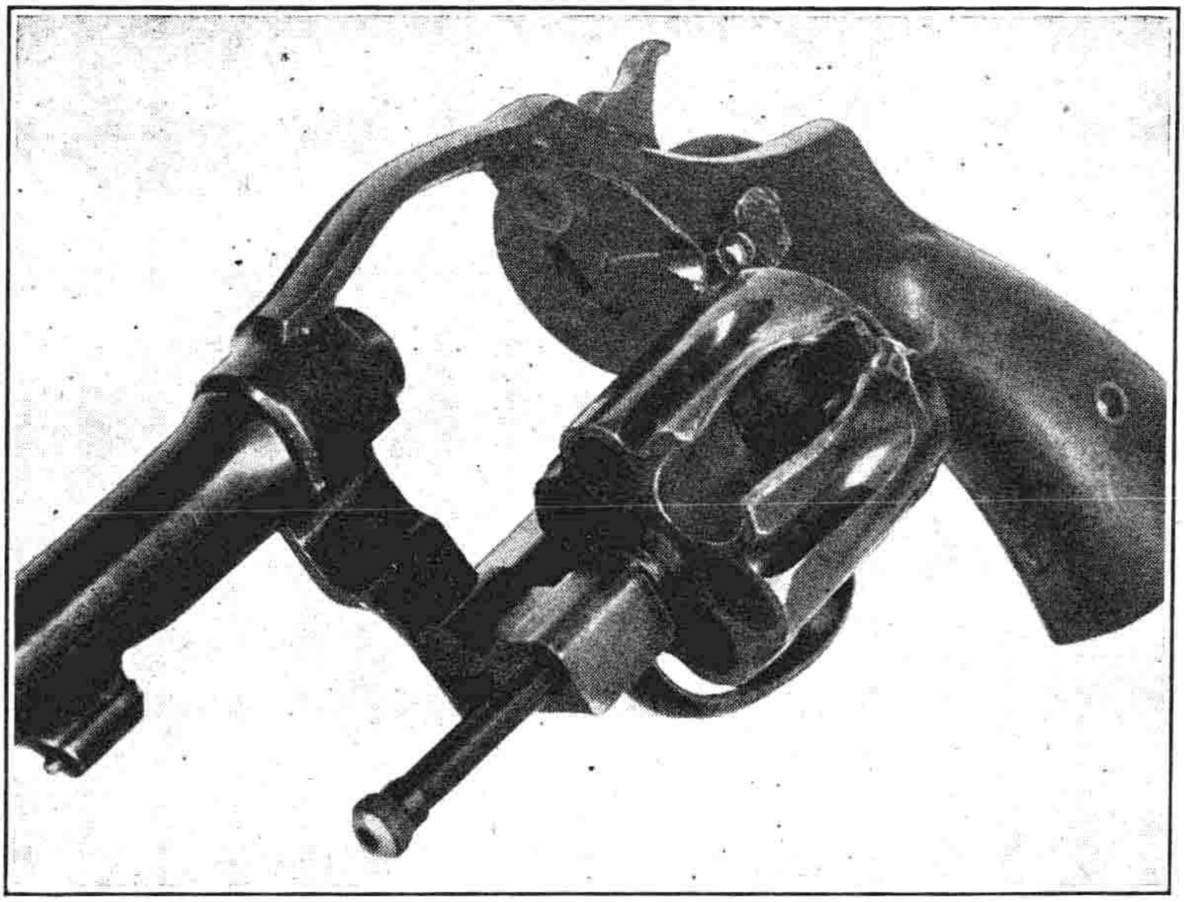
Another way in which explosives can act is to *detonate*. Take dynamite, for example. A stick of dynamite, which is only nitroglycerine dissolved in porous earth, may be cut in small pieces and the pieces thrown in the fire one by one, and they will burn quietly. But if a blasting cap is exploded in contact with the dynamite, a sudden wave of chemical change will pass through the whole mass, and it will all turn into gas practically instantaneously. The action is so sudden that it will disrupt and wreck even the strongest materials. If it happens inside a gun barrel, it will break the barrel before the bullet has time to move. This extremely sudden change of an explosive into a gas all at one time is called a *detonation*.



This gun was burst by using a double charge of smokeless powder. With most modern pistol cartridges, a double charge will come very close to bursting the gun.

Guncotton and nitroglycerine are both peculiarly sensitive to being detonated, and smokeless powders are all made either of guncotton, nitroglycerine, or both, or of some other nitrocompound resembling guncotton. It is true that they are treated chemically in such a manner as to remove nearly all chance of detonating them by any ordinary means; but if a very large charge of pistol powder is compressed into a very small space and exploded under conditions giving rise to very high pressures, a detonation will sometimes occur.

It is practically impossible to burst a modern high grade pistol or revolver merely by high pressure; but as the powder charge is increased and the pressure gets higher and higher, suddenly a point will be reached where the character of the explosion changes to that of a detonation. When this occurs, the gun will be wrecked, no matter how good the material is or how thick the walls are made. When a detonation occurs, the nearest thing moves, no matter what it is.



This .45 caliber Model of 1917 revolver damaged in a test, shows the result of using a double charge of smokeless powder.

Experience has shown that with high powered revolvers, a double charge of smokeless powder will sometimes burst the gun. This is of particular interest because a double charge is what would result if a cartridge were accidentally put under the powder measure twice in either hand or factory loading.

An exhaustive series of tests was once carried out with the .45 Colt cartridge, loaded with a 255 grain bullet and a standard factory charge of 5.9 grains of Bullseye No. 2. A number of cartridges were loaded with one extra grain, two extra grains, three extra grains, and four extra grains of powder. All these charges, running up to 9.9 grains of powder were fired with no damage to the weapon. However, when some charges of five grains extra, or a total of 10.9 grains, were tried, the revolver burst on the third shot. The test was then repeated, with another revolver, which burst on the 4th shot.

Some cartridges were then loaded with 6 grains extra, or 11.9 grains, which was just a little over a double charge. The revolver burst on the fourth shot. The test was repeated, and again the revolver burst, this time on the third shot.

A normal charge was then used, but two bullets were inserted, both resting together. The revolver burst when fired.

Occasionally, from some unknown cause, most likely an overload, a cartridge will detonate and burst a revolver. A theory was evolved that with cartridges loaded with nitro-glycerine powders, long exposure to prolonged heat might cause the nitro-glycerine to exude, and that as a result, the cartridge might detonate when fired. To test this possibility, cartridges were exposed to varying degrees of heat for varying lengths of time, and then fired. In no case was any dangerous pressure recorded, though in a number of cases hangfires and misfires occurred through having nitro-glycerine exude and deaden the primer. Likewise the exposure of cartridges to extreme cold did not cause any high pressures.

The most remarkable thing to my mind, is the tremendous amount of abuse that the modern revolver or automatic pistol of high quality will stand without giving way. Not long ago I saw an astonishing exhibit on the desk of Mr. Fred T. Moore, Vice President and General Manager of Colt's Patent Firearms Mfg. Co. It is quite easy to understand that with thousands of people all over the country experimenting with reloading cartridges, and especially with many of them trying to develop high speed loads, cases will occur where the experiment will result in the production of a load that no gun can stand, and a burst revolver will be the result. Most often the user will then write to the maker of the arm and state that the gun was defective, and demand its replacement free of charge.

Various are the excuses used in such a case. Sometimes the claim will be that the heat treatment in the cylinder is defective; or the claim may be that the design is too weak because the walls of the cylinder are not thick enough; or that the thin section of the cylinder wall where the chamber comes nearest to the outside wall is too thin.

When one man blew up a gun with a double load and then said that the heat treatment was defective, Mr. Moore took a cylinder and burnt it in the fire, so as to destroy all the heat treatment. The gun with this soft cylinder in it performed as usual.

When another man said that the walls of the cylinder were defective in design in that they were not thick enough, Mr. Moore took a cylinder of the same kind and shaved the walls down to a fraction of their original thickness The revolver passed the proof tests and an exhaustive firing test without any trouble, thus proving that the cylinder walls are actually made much stronger than necessary.

When another man thought the design was defective in that the chambers approached too close to the cylinder walls, Mr. Moore took a cylinder and actually sawed through this thin section in each chamber. When the gun was fired, the walls of the cylinder bent over slightly, so as to open the crack a little wider, and close the crack on the adjacent cylinders; but that is all that happened.

In a revolver an overload of powder will never burst a barrel, but if it damages the gun it will damage the cylinder. In revolvers it is pretty safe to say that a damaged barrel is always caused by some obstruction and a damaged cylinder by an overcharge, or high pressure.

In the Government automatic an overcharge generally splits the barrel at the bottom between the two lugs, and the escaping gases bulge the projecting forward part of the receiver and generally also bulge out the slide. Usually the magazine is also blown out and the grips are split, which may injure the shooter's hand.

In all my own experience with hand firearms the only casualty I ever had was produced by experimenting with a Government automatic pistol with a special barrel to shoot blank cartridges, which I was attempting to develop at the time. The charge was 5 grains of EC blank-cartridge powder, which is quite a safe charge ordinarily when no bullet is used; but in this case there was a choke screwed into the barrel near the muzzle to furnish sufficient power to operate the mechanism, and somehow this choke became stopped up from one of the wads from one of the blank cartridges. On firing the succeeding cartridge, the whole top of the pistol was simply cleaned off the frame, leaving me holding just the receiver, much astonished, although not in the least harmed.

Mechanical Difficulties

With the advent of the modern high grade revolver and automatic pistol of good design, many of the mechanical difficulties formerly encountered have become a thing of the past. For example, in the old Colt .38 caliber revolvers formerly (1894 to 1911) used in the Army, a frequent cause of trouble was the breakage of the spring holding the hand or pawl which turned the cylinder. With this spring broken, the cylinder would not turn when the hammer was cocked, unless the muzzle of the gun was held pointing downward. In this case, the force of gravity dropped the pawl in place, and the cylinder would sometimes revolve.

With the modern revolver, the hammer nose or firing pin will occasionally break. This is usually due to faulty heat treatment of the part. Fortunately this accident is very rare with guns made at the present time. The accident puts the gun out of commission until another piece can be obtained and installed.

Occasionally a gun will be seen in which the firing pin hole in the standing part of the breech is too large, or is out of shape. This may cause a jam by allowing the soft metal of the primer to flow back into the hole under the pressure of the explosion. With high pressures and very soft primers, this difficulty may be experienced even with a well made and properly fitting firing pin and firing pin hole. The remedy in this case is to change to another make of ammunition.

Sometimes with automatic pistols, the thumb safety may become worn, or may not fit properly in the first place, so that when it is put in the "Safe" position, the gun can still be fired. The remedy is to replace the defective part with a new one.

In using single shot target pistols with a spring ejector, it frequently happens that when the gun is opened, the cartridge is not ejected. The only thing to do in this case is to push out the empty shell with a cleaning rod, taking care to keep the face and eyes out of line with the breech, for as soon as the cartridge is started from its seat, the spring will throw it out with a considerable amount of force. This failure of the ejector is usually due to the accumulation of lubricating grease from the cartridges. An occasional cleaning of the chamber of the gun with a light oil will usually prevent this trouble.

Even the hand ejector ordinarily found on revolvers is not free from its troubles, as it is quite easy for one or more of the empty cartridges to fall under the ejector and become caught so that it is somewhat troublesome to remove, and causes a considerable delay in reloading. The best way to avoid this is to hold the gun muzzle up when ejecting the empty shells. This will allow them to fall clear. In this connection it may be remarked that the useless flourish indulged in by some shooters who imitate wild west novels by swinging the revolver upward and backward when they cock it is said to have originated from the very practical necessity in the old days of the cap and ball muzzle loader of getting rid of the spent caps without getting them entangled with the mechanism. Before firing, the caps were a snug fit on the nipples of the cylinder; but when they exploded, they would split open and were ready to fall off and get in the works as soon as the hammer was cocked. Hence the practice of raising the gun over the right shoulder with the muzzle up when cocking the hammer, so that the spent cap could fall clear.

If the metal in the head of the rim fire cartridge happens to be weak or defective, or if the pressure happens to be excessive, the head of the cartridge may split when it is fired, and the result will be a disagreeable and dangerous escape of gas that may burn or cut the fingers of the revolver shooter. This accident is more likely to happen with the high speed .22 cartridges, which have a very high pressure, than it was with the old style low pressure cartridges. In order to allow the use of high speed cartridges with safety in revolvers, Smith & Wesson brought out their K-.22 with a cylinder having countersunk recesses to receive the heads of the rim fire cartridge, instead of merely allowing the head of the cartridge to lie in the space between the cylinder and the frame, as had formerly been the practice. This obvious but highly commendable improvement was so self evidently desirable that it was almost at once adopted by every other maker of importance.

There are on the market a number of revolvers chambered for long cartridges in which it is possible to use a similar cartridge of the same caliber but shorter in length. For example, .22 BB Caps, .22 CB Caps, .22 Short, .22 Long, and .22 Long Rifle cartridges may all be used in most .22 revolvers; the .38 Long Colt and the much longer and more powerful .38 special may be used in the same gun; and all guns chambered for the .44 S. & W. Special will also take the .44 S. & W. Russian, which is two tenths of an inch shorter.

The reader of firearms literature will often see warnings against this practice; but in general I see no objection to it. In fact I have personally fired many thousands of short cartridges in handguns chambered for longer ones, with no trouble.

It is true that the long continued use of short cartridges in long chambers may tend to cause corrosion or a slight burning or roughening of the chamber to take place just where the mouth of the short cartridge rests, so that when long cartridges are later used in the same chamber, this roughness may cause difficulties in extraction. However, this effect was much more likely to happen when the old fashioned corrosive primers were in use. With the modern non-corrosive primers there is little or no danger of any trouble from this cause, and anyway, the trouble at its worst was not serious. It merely meant a slight difficulty in extraction, or else the fitting of a new cylinder at a few dollars cost. For example, when living in Florida some years ago, I used to carry a .22 Colt Police Positive Target Revolver with me whenever I walked on the beach or in the woods; and I shot so much with this gun that I took to using the .22 shorts as a matter of economy. I used to buy them by the case of 10,000, and after using several cases I still found no difficulty with the gun, though I used it carefully and always cleaned it as soon as I had finished shooting. Anyway, the money I saved in ammunition would have paid for several new cylinders had it been necessary.

A more serious criticism of this practice of using short cartridges in long chambers is the statement sometimes heard that this practice will result in bulging or swelling the breech of the barrel where it is coned out to form a bullet seat. The theory is that the bullet gets to going with a considerable amount of velocity and then passes from the cylinder to the barrel, where it encounters the cone leading into the rifling. It is said that the sudden retardation of the rapidly moving bullet when it enters the coned rear section of the barrel will cause the barrel to bulge in time. This sounds reasonable; but before coming to any conclusion, it might be well to remember that every revolver bullet has to jump about half an inch before it comes to the rifling, so that we might with equal reason expect the same effect with the standard cartridge for which the gun was originally chambered, especially as the regular cartridge usually has a more powerful load than the short cartridge.

In fact, it is probable that this bulging of the rear end of the barrel from the impact of the bullet does sometimes occur, especially with long soft bullets and heavy powder charges; but I have never personally seen a case where this occurred from using short cartridges in long chambers; and I have had a lot of experience along this line, as for years I used thousands of .38 Long Colt Cartridges in my S. & W. .38 Military and Police and in my Officer's Model Target for rapid fire practice. At one time the Army had a large stock of these .38 Long Colt Cartridges, and they were issued to the competitors at Camp Perry in large quantities. One year as Ordnance Officer of the National Matches at that place I issued 20,000 of these cartridges, nearly all of which were shot by competitors in .38 Special revolvers, and there was no trouble reported. Consequently I never hesitate to use the .38 Long Colt in the .38 Special gun, or the .44 Russian in the .44 Special gun when it suits my purpose to do so.

Barrel Life

Naturally the user of a gun will consider that after he has used the gun for many thousands of shots, some wear will have taken place inside the barrel, and he will want to know how much this will affect the accuracy, and how much shooting can be done before the barrel must be replaced.

The answer depends on what kind of ammunition is used, and on what kind of care is given to the gun. Most barrels that have to be replaced have become unserviceable through rust and pitting caused by neglect and not by wear. In fact, it is very rare indeed for a revolver barrel to become worn out from shooting.

In high powered rifles using jacketed bullets, the case is different. The gases are under very high pressure and temperature, and the bullet seat or origin of the rifling rapidly becomes *eroded* with use. Moreover the jacketed bullets cause a very large amount of friction and barrel wear. Erosion and barrel wear will ruin a high powered rifle barrel in from three thousand to ten thousand shots, depending on the kind of powder used, etc.; but corrosion and pitting from rust and neglect may ruin any gun in a few days. It is well to bear in mind that erosion and corrosion, the two great enemies of gun barrels, are entirely different things, and operate in entirely different ways.

The principal cause of ruined barrels from corrosion is failure to clean them promptly and properly after using. This is less important now that non-corrosive primers are in use; but prompt and thorough cleaning is still the best gun insurance.

For years all small arms primers contained a chemical, potassium chlorate, which in firing the primer is changed into potassium chloride and deposited in the barrel. This potassium chloride has a very great affinity for moisture, and when wet chloride is in contact with steel an electrolytic action starts, which rapidly dissolves the steel. This is the cause of the corrosion which ruins so many gun barrels. The chloride must be removed before the gun is put away after firing. If it is allowed to stand even overnight in an ordinary atmosphere, the surface of the steel will be attacked and roughened; and once this has occurred, the matter of cleaning becomes increasingly difficult.

Fortunately the cartridge companies have all learned how to make primers containing no chlorate of potash, and these primers are non-corrosive. A gun fired with ammunition containing non-corrosive primers is no more liable to rust inside than outside, and immediate cleaning is not so important. But of course any piece of iron or steel will rust in time if it is left to stand without any oil on the surface, so that even with non-corrosive primers, a certain amount of care is necessary.

Moreover, not all cartridges are made with non-corrosive primers. The most popular cartridges for target use in the .22 caliber have long been those loaded with Lesmok powder, which is in effect a mixture of black and smokeless powders. Non-corrosive primers are not used with this powder, and moreover, the residue of the powder itself contains potassium salts which are corrosive. So the corrosion problem remains with us.

Recently a number of new steels called stainless have been coming more and more prominently into use for making cutlery, and for other purposes. These steels contain about twelve per cent or more of chromium, and will not rust or corrode. Numerous attempts have been made to produce rifle or pistol barrels from this material, so as to do away with all trouble from corrosion, but the stainless steels are very difficult to machine accurately, and the making of rifle barrels from it has proved to be an almost impossible task so far, though progress is always being made in improving the machinability of these materials, and it is possible that in the not too distant future stainless steel barrels may be the rule. Already a lot of 2000 stainless steel barrels for the .45 automatic pistol has been made by the Ordnance Department at Springfield Armory.

When a barrel becomes slightly rusted, the accuracy does not change at all, but the surface becomes roughened, and the barrel becomes more likely to suffer from leading if lead bullets are used. If the barrel is for an automatic pistol, where jacketed bullets are used exclusively, no difference in the performance of a slightly rusted barrel and a new barrel can be noticed.

When the corrosion progresses further, pits will develop in the metal. In other words, little depressions will be seen where the metal has been eaten away by rust. Small pits do no harm to the accuracy when jacketed bullets are used, but they cause leading and inaccuracy with lead bullets. When a pit is wide enough to extend from one land or groove to the next, and is a quarter of an inch or more in length, the barrel should be considered unserviceable.

Pistols and revolvers using lead bullets, properly lubricated, will practically never wear out from barrel wear. I am acquainted with several nationally known marksmen who are still shooting .38 Special revolvers that have been shot from 30,000 to 50,000 times, and these guns are still winning prizes the same as ever.

Major Douglas B. Wesson of Smith & Wesson writes me that some of the test revolvers in the ammunition factories have been fired over 300,000 times, and are still accurate. He further says, "I can state definitely that in 1912 or 1913 I personally inspected two .44 Russian Single Actions belonging to Ad Topperwein, and found the barrels in perfect shape inside, both by visual inspection and by gauging, and at that time one had been shot something over 250,000 rounds, and the other over 300,000 rounds, and he continued to use these same guns with the same barrels for years after that time."

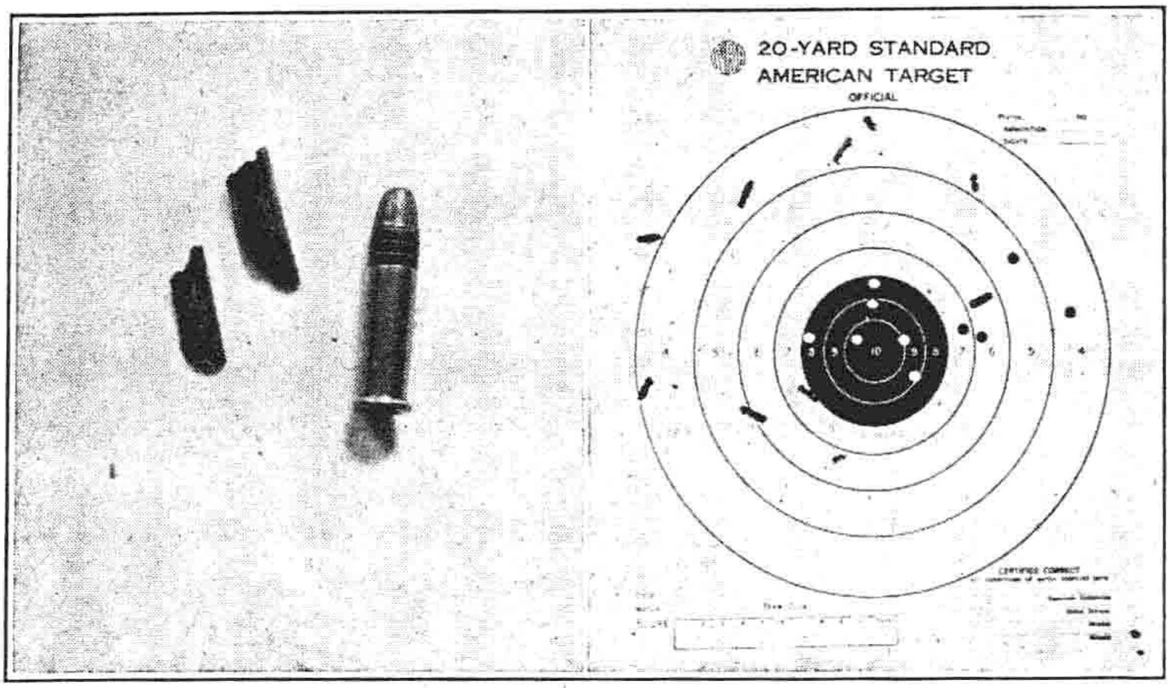
Thus we can see that with lubricated lead bullets there is no reason to worry about wearing out a barrel from shooting. The life of the barrel is, for all practical purposes, indefinite.

It is quite another thing, however, with jacketed bullets. They are made of much harder material, and there is no lubrication to cut down the friction, so that barrel wear is rapid. I have personally conducted several tests which show that with the .45 automatic pistol or the .45 Model 1917 revolver using jacketed bullets, the barrel life is only about five thousand or six thousand rounds.

Improperly lubricated lead bullets will cause a rapid temporary loss of accuracy through what is called *leading*. Owing to the great heat and friction of the passage of the bullet through the barrel, a part of the lead from the bullet sometimes rubs off and sticks to the barrel. When this happens, the accuracy suffers until the offending particles of lead are removed from the barrel.

Some of the "dry" or unlubricated .22 caliber cartridges which have recently been placed on the market under various trade names are very bad offenders in regard to leading. When this book was in preparation I visited the publisher, Mr. T. G. Samworth, at his residence in North Carolina, and I took with me several new arms, and a quantity of various makes of ammunition. One morning was spent in trying a new .22 caliber revolver. During the fore-noon, several boxes of these .22s were shot; not because I like them, but merely to see what the result would be. At first the accuracy and performance of both gun and ammunition were all that could be desired; but suddenly I noticed that I was missing an unusually large number of easy shots at tin cans and other improvised targets, so we put up a regular target at 20 yards, and I fired five shots, with not a single hit! I then went up to ten yards, with the same result. Finally I did get a few shots on the bottom of the paper, but they were all keyholes; that is, the bullets had struck sideways.

We then took the gun inside and looked into the barrel and found that for over an inch forward of the breech the diameter was reduced by fully one third. On pulling a brass brush through the barrel a cylinder of lead was dislodged which formed a perfect cast of the inside of the barrel. We scrubbed out the barrel with the brass brush, and then again tried it at 20 yards. Result, ten shots with all but one in the black, and that one was close.



Left: Flakes of lead removed from a .22 caliber revolver after firing several boxes of the unlubricated, or "dry" type of .22 caliber cartridges through it. The lead formed a perfect cast of the bore for about three quarters of an inch near the breech. Temporarily, the accuracy of the revolver was utterly destroyed, but it was fully restored as soon as the leading had been removed.

Right: Effect of shooting about a hundred "dry" type .22 caliber cartridges of a well known make in a revolver. The cleancut holes were made with Remington Sharp Shoulder Cartridges fired from 20 yards. Then the gun was used for a while with "dry" cartridges of another make. The keyholed shots were fired from 10 yards with dry ammunition after the gun had begun to show signs of being leaded.

This was the worst case of leading that I have ever seen, but I have found that the same thing will happen every time if .22 cartridges of the dry type are fired rapidly. Owing to the rapidity with which it is usually fired, this trouble will occur very readily in the Colt Woodsman or any other automatic, when using the dry cartridges; but it does not occur if proper greased cartridges are used. The moral is that the dry cartridges should not be used. The cartridge companies know perfectly well that the dry cartridges are liable to cause leading, but they have to make them and sell them because the great number of shooters who know very little about accuracy and want dry cartridges that can be carried loose in the pocket will buy this kind anyway, and if one company does not make them, its competitor will get the business.

Even with lubricated bullets, leading sometimes occurs. Occasionally in a match, the shooter who has been shooting for sometime may notice that the shots are getting hard to hold in the black. He then runs a rag through his barrel, and on looking at it carefully he will notice a few little shiny flakes. This is a mild case of leading. It will reduce the accuracy slightly until the lead is removed.

Leading in a fairly serious form is common among the users of hand loaded ammunition. Usually the cause is insufficient lubrication, too large a bullet size, or too soft a mixture for the bullet metal. A rough barrel will tend to aggravate leading from any cause.

Fortunately, leading does not permanently harm a barrel, for the lead can readily be removed, and then the steel barrel remains in the same condition as before, provided that the lead was not left in the barrel long enough for corrosion to take place underneath. The easiest way to remove leading is with a brass cleaning brush. The brass is softer than the steel of the barrel and will not scratch the steel, but it loosens and removes the lead. In stubborn cases, the barrel may be corked and filled with metallic mercury, which will soften and dissolve the lead. Allow the mercury to remain in the barrel 12 hours, then pour it out and clean the barrel with good tight cloth patches, and all traces of the lead will be removed.

The condition of a gun barrel can be determined with sufficient accuracy for all practical purposes by visual inspection. In a new barrel the surface is smooth and bright and free from any spots or discolorations or irregularities and the edges of the lands and grooves are sharp and distinct.

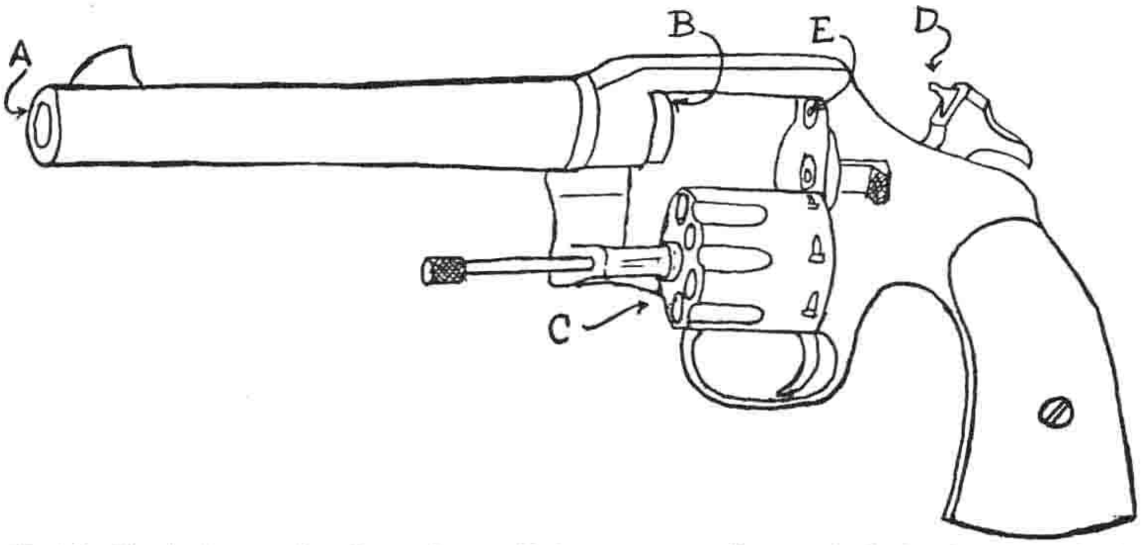
If the barrel has suffered from excessive wear the edges of the lands especially towards the breech will be rounded over. Wear always shows up first at the breech end of the barrel and it is always advisable to examine the barrel from the breech rather than from the muzzle if this is possible. Even a considerably worn barrel will look good when viewed from the muzzle end.

If the surface of the metal instead of being uniformly bright and shiny has a dull or grayish appearance, or if it is covered with little fine, black specks, it has been allowed to rust slightly and the surface has become roughened. In an automatic pistol using jacketed bullets this will do no harm except to cause a slightly increased tendency to rust in the future.

If one or more little, oblong or irregular dark splotches are visible on the surface these are pits caused by the metal being more or less eaten away at the spot from rusting.

CARE AND CLEANING

The pistol or revolver, like any other object made of steel or iron, will rust unless it is kept oiled or greased. In fact a pistol is more subject to rusting than most objects of steel because it is liable to be handled in hot weather with moist hands and the film of perspiration thus left on the surface has a chemical effect which will cause a rust in a very short time.



Sketch illustrates parts of revolver which are generally overlooked when the shooter is cleaning the arm. A, the end of the barrel; B, cylinder strap, right over barrel; C, front of cylinder; D, hammer nose and face of hammer; E, firing-pin channel and hammer cavity. **Corrosive gases are prone to work into D and E.**

When any gun is first received from the factory the working parts will already have been oiled and the outside covered over with a light film of oil.

In order to preserve a gun from rust it is necessary to wipe the surface with a slightly oily cloth after the gun has been handled and before putting it away; otherwise finger prints and handprints will show up as rust streaks. After a gun has been fired additional care is necessary. The products of the powder combustion must be removed from the inside of the barrel and cylinder; and the smoke of powder gas must be removed from around the joint between the barrel and cylinder in a revolver and from the breech block and other working parts of an automatic pistol.

Immediately after shooting and before putting away the gun a dry canton flannel patch on a cleaning rod should be run through the barrel and each chamber of the cylinder, and this should be repeated with new patches until the patches come out clean and the barrel and cylinder look bright inside.

Then saturate a patch with nitro solvent or some gun cleaning oil and with this oily patch wipe out the interior of the barrel and cylinder thoroughly. Also clean off the front face of the cylinder and the frame of the gun wherever the powder gas has reached it. The firing pin or point of the hammer nose should be wiped off with this same oily patch. If the gun is to be used again in a few days it can be put away in this condition, but if on the other hand it is to be kept for sometime without shooting it again it is advisable to clean the barrel and cylinder out once more with a dry patch and then coat with a patch saturated with gun grease.

The outside of the gun and all places where the fingers have touched should be wiped off with an oily rag before the gun is put away. If the gun is to be kept for some time without using it again the outside should be gone over with a rag saturated with gun grease so as to leave a light coating of the grease on all parts exposed to the air. When the gun is laid away it should not be put in a leather holster or wrapped in a cloth or put in contact with pasteboard. These substances all attract moisture and are likely to cause rusting.

A gun treated as described above and laid away in a dry place will keep in good condition indefinitely without further attention.

In cleaning automatic pistols it simplifies matters and makes cleaning easier and more thorough if the breech block is removed so as to expose the breech of the barrel in guns such as the Woodsman; or if the barrel is taken out in pistols such as the Colt Automatic in which the barrel can easily be removed. The easiest revolvers to clean are those such as the Harrington & Richardson Sportsman and the Iver Johnson Supershot in which the frame is hinged so that the barrel can be tipped up. In both these guns the cylinder is easily and quickly removable. By tipping up the barrel and removing the cylinder both the barrel and the cylinder and those parts of the frame reached by the powder gas become easily accessible.

Two different kinds of cleaning material should be on hand; a nitro solvent or gun oil and a heavy gun grease similar in consistency to vaseline. There are a number of commercial preparations on the market in both classes. Most of the big arms companies make a gun grease sold in collapsible tubes like toothpaste. Any of these preparations put up by any of the big arms companies may be relied on to be free from acid and quite suitable for indefinitely preserving the gun from corrosion. Both the gun grease and the nitro solvent of various kinds may be found on sale at nearly all sporting goods stores.

One of the most famous and satisfactory nitro solvent oils that has ever been developed is the formula of the late Dr. Hudson. It is often made up in quantities by gun clubs for the use of their members and is very satisfactory. To make ½ gallon of this mixture use the following quantities of the materials given:

Amyl Acetate—90 c. c. or 6 parts
Acetone—285 c. c. or 19 parts
Spirits of Turpentine—285 c. c. or 19 parts
Sperm oil—870 c. c. or 58 parts
Pratt's Astral Oil—390 c. c. or 26 parts

Pratt's Astral Oil is simply a very highly refined, acid free kerosene, originally produced by Pratt & Company of Brooklyn. This was such a pure product that no one in the trade was able to duplicate it successfully and there was so much demand for it that the Standard Oil Company ultimately bought the plant and continued the manufacture. This product is still marketed by the Standard Oil Company and should be obtainable from any of their distributing centers. The price is usually somewhat higher than that of ordinary gasoline. If any difficulty is had in obtaining Pratt's Astral Oil a material about equally good for the purpose can be obtained from almost any oil concern by asking for double refined kerosene guaranteed to be neutral, that is free from either acid or alkali.

This Hudson's Cleaner is an extremely satisfactory material for both cleaning and preserving pistols and revolvers. Some of the large arms companies use it regularly and a number of years ago when I was a member of the Springfield Revolver Club a number of the members of this club used it exclusively. For some years the only care I ever gave any of my pistols or revolvers was to clean them thoroughly with this material just after shooting unless I was going to lay them away for a long time in which case I applied gun grease as described above. With this very simple treatment I have never suffered from having any of my guns rust.

Another excellent cleaner which can be obtained on the market is a sort of emulsion of oil and water known as Chloroil. This material was made especially to dissolve the salty residue of the primer combustion. The oily consistency of the cleaner also protects a gun from rust for a long time. At the present time when I am using a gun at frequent intervals I merely clean it out thoroughly with a bristle brush dipped in Chloroil and then put it in the rack still dripping with the Chloroil and leave it there until I get ready to shoot it again. Of course if a gun is to be left unused for any length of time it should be dried and lightly coated inside and out with grease as described above.

Besides mere cleaning, all firearms require a certain amount of lubrication to enable the mechanism to function smoothly and without friction. Several of the commercial nitro solvents have the consistency of a light oil, and will serve very well for lubrication. It is somewhat more desirable, however, to use a plain light lubricating oil, of good grade, such as sewing machine or typewriter oil for this purpose. The mechanism requires very little oil, and requires oiling only at long intervals. It is a mistake to have the mechanism reeking with oil, as oil is the greatest enemy of good ignition in cartridges, and if oil works into the cartridge or primer misfires or hangfires will result. Never put enough oil on the gun to make the cartridges oily.

Points which require most frequent oiling are the parts where the slide and frame rub together on automatic pistols, and the hub of the cylinder, especially at the forward end, in revolvers.

Oil should be used very sparingly in dusty or sandy climates, such as the desert, as otherwise it will tend to collect dust and this accumulation may cause malfunctions. In some very dry locations where dust storms are frequent, it is better to keep the gun entirely free from oil.

In the arctic regions and other very cold places it is advisable to wipe off all oil, as it may freeze and cause jams.

Many guns when they come from the factory may have the barrel nearly full of heavy grease. Naturally if the gun was fired before this grease was removed, great damage would be done. If there is enough grease or oil in the barrel to see, it is best to run a rag through the barrel to remove the grease or oil before firing.

Most guns will shoot in a slightly different spot when the barrel is oiled from what they will when it is dry. Hence in starting a string of shots in a match, it is well to fire a warming or fouling shot through the barrel before beginning the actual match.

When Lesmok powder is used, a considerable amount of residue will collect in the gun barrel, and it is desirable to run a dry patch through the barrel after each twenty or more shots. With smokeless powder this is not necessary.

One often hears the shooter advised always to clean the gun from the breech, and never from the muzzle, for fear of wearing the muzzle with the cleaning rod. Fortunately this is not very important, for the Colt and Smith & Wesson revolvers with swing-out cylinders cannot be cleaned from the breech. The objection to cleaning from the muzzle is the fear that the cleaning rod may wear or injure the rifling at the muzzle; but as mentioned above, this is not really important, for experience has shown that while erosion at the bullet seat and in the lands just forward of the bullet seat will cause inaccuracy, wear at the muzzle will not. Even very serious mutilation of the muzzle of a gun with a file will not appreciably change the size of the groups; but it will change their location; that is the group may be higher or lower, or to one side or the other. These changes can of course be compensated for by sight changes.

How to Select a Good Revolver or Pistol

It is of great practical value to know what points to check up when buying a revolver or pistol of any kind, and this is especially important when the arm to be purchased is a second hand one.

First clean out the bore and chambers, and examine their interior condition and appearance in a good light. The barrel should be examined from the breech if possible. In most automatic pistols the barrel can be removed, and this should be done, as it facilitates the examination greatly. Single shot target pistols can all be opened so that the barrel can be viewed from the breech end. In most revolvers of the hinged frame variety, the cylinder can readily be removed.

The bore should be bright throughout its entire length, with no pits or marks of corrosion, and the edges of the lands should be clear and sharp. There should be no nicks in the muzzle nor should it be worn or "belled" through the improper use of the cleaning rod. Each chamber of the cylinder should be clean and free of rust spots or pitting; look closely in the case of a .22 and see that the chamber has not been unduly eroded through the excessive use of .22 shorts.

Cock the hammer and hold the gun up sideways to the light while you examine the clearance between the face of the cylinder and the rear end of the barrel. There should be a minimum of light showing, and this clearance should be the same for each chamber when the cylinder is revolved by hand. The end of the barrel should be square and true from both sides. There should be no appreciable play back and forth when the cylinder is worked lengthwise with the fingers.

Cock the hammer and examine the sidewise play in the cylinder when it is locked in position for firing. This is a most important point for if there is much play when the cylinder is in the firing position the gun may go off when the chamber is not well lined up with the barrel and this will result in shaving of lead and consequent serious inaccuracy. It is well to bear in mind, however, that all revolvers have more or less play in the cylinder when the gun is in the position of rest; that is, with the hammer down and the trigger forward. When the hammer is cocked the hand or pawl rotates the cylinder until the cylinder latch drops in place and holds the cylinder from further rotation. At this point there should be very little play but there is usually some. Now when the trigger is further pulled to discharge the piece the remaining loose play of the cylinder between the pawl and the cylinder stop is taken out and the cylinder should be locked perfectly solid in line with the barrel. For this reason the sidewise play of the cylinder must be tested after cocking the hammer and pulling the trigger, while the trigger is still held all the way back. In this position there should be no play or rotation in the cylinder. The same test should be made for each chamber in the cylinder as it might be tight in one position and at the same time the notch for the cylinder lock might be worn or displaced when some other chamber was in line.

Test the gun for rotation of the cylinder by pointing muzzle upward and holding back the cylinder with the left hand while cocking the gun with the right. In some guns the breakage of the spring which operates the hand or pawl will allow this part to drop out of action when the muzzle is elevated and the cylinder will not revolve; while on the other hand with the muzzle pointed downward gravity makes the pawl drop into its notch and the cylinder will rotate just as though the spring was not broken.

Swing out the cylinder and test it for rigidity; neither cylinder nor crane should show loose play. Slide the ejector rod back and forth to test its fit and working qualities. It should slide back freely and be returned to place readily by its spring. Examine closely the ratchet on the end of ejector rod; it should have sharp edges and should not be worn or burred to any extent. The cylinder lock in the bottom of the frame should have sharp edges and be of full width; it should also work freely and positively. Depress it with the forefinger a few times and see that the spring still has life.

If the gun is a .22 caliber examine the edges of the chamber where the hammer nose or firing pin rests. It should not be burred or dented.

With the cylinder swung out snap the hammer and by holding the trigger down, test the firing pin for protrusion. It should project sufficiently to explode the primer and it should not show any deformation, rusting or pitting. Notice whether or not there is any wear or corroding away of the firing pin hole. It should not be enlarged to any extent. Examine the pawl or hand which rotates the cylinder. It should not be worn away on its upper end but should rotate each chamber completely to its locked position. Cock the hammer and notice the condition of the hammer nose. It should be clean, well formed and it should not show any corrosion or battering. The cavity into which it fits when down should not be rusted or eaten away with primer corrosion. In the case of a revolver having a separate firing pin it should work freely and be of sufficient length to function properly; the rear end should not be burred over and the firing pin should not be rusted or stuck. Examine the firing pin particularly to be sure it is not broken, as sometimes revolvers with separate firing pins will be found to have the firing pin broken in the middle so that the break is hardly noticeable. The front end of the firing pin protrudes through when it is struck by the hammer but it is not retracted when the rear end of the firing pin recedes when the hammer is cocked. If the hammer has a loose hammer nose which acts as a firing pin it should have a considerable amount of play on its pivot.

Snap the hammer a few times and notice its action. Percussion should be good and the trigger should snap back smoothly and quickly to its forward position. Test the double action pull which should work smoothly and allow the hammer to "break" cleanly from the notch when it falls. When at full cock the hammer should notch at the rear of its travel with but very little additional play.

The side plate should not be sprung away from the frame at any point but should fit flush all around. The screw which fastens it should not have burred heads or torn slots; if they do it is an indication of possible repairs in the past or at least that the arm has been disassembled by an unskillful person.

Grips should fit to the butt with no looseness and no signs of warping. Checkering should have clean, sharp diamonds which are not worn smooth. Sights should not be bent or dented and in the case of target guns there should be no lost motion in the sights.

In the case of an obsolete Army sidearm or a gun bought from any large stock of standard weapons such as discarded police models, etc., check up on the serial number found on the butt, frame, cylinders and barrel and make certain these are all the same, otherwise the gun is probably an assembled job made up by fitting together a lot of spare parts and if so you don't want it. The color on the bluing on all main parts should be of the same shade or show an equal amount of wear. If there is no serial number showing, or there is indication that they have been altered or ground off do not accept the gun under any condition. In many jurisdictions the mere possession of a gun with altered number is a presumption of illegal possession or violation of some of the various firearms laws.

If in your examination you find the words "Spain" tucked up under the trigger guard or "Made in Spain" in small type or the wording "for Smith & Wesson ctg." with only the Smith & Wesson part readable don't accept the gun as a gift. It is one of the notorious Spanish immitations of standard American arms and the quality is utterly undependable.

In the case of automatic pistols test the slide for looseness on the frame. If there is very much play the gun will most likely be inaccurate. See if the barrel has any loose motion in the barrel bushing when the slide is closed. It should be a snug fit. Snap the gun and holding back the trigger draw the slide to the rear and let it go forward again, then release the trigger and pull it and the mechanism should snap. If it does not then the disconnector has failed to work and the hammer or firing pin has followed the slide down. If the gun is a .45 Government automatic or a Super .38 automatic test the disconnector as follows: Cock the piece and shove the slide one-quarter inch to the rear; hold the slide in that position and squeeze the trigger. Let the slide go forward, maintaining the pressure on the trigger. If the hammer falls, the disconnector is worn on top and must be replaced. Pull the slide all the way to the rear and engage the slide top. Squeeze the trigger and at the same time release the slide. The hammer should not fall. Release the pressure on the trigger and then squeeze it. The hammer should then fall. The disconnector prevents the release of the hammer unless the slide and barrel are in the forward position safely interlocked.

The first test indicates that the disconnector is sufficiently long to be forced, by the rear surface of the slide, from between the sear and trigger. With it in this position a release of the trigger is necessary to allow the disconnector to move upward into the intervening space between the sear and trigger. The slide prevents this until it is allowed to go forward, uncovering the nose of the disconnector.

The second test indicates that the disconnector is of sufficient length to be forced, by the forward surface of the slide, from between the sear and trigger allowing the sear to engage the hammer while the slide is going forward, thereby preventing a follow down. This test, when associated with the first test, indicates that the cam surface under the slide is proper to make a disconnector of proper length function throughout the travel of the slide. In so doing, the sear, disconnector, and trigger are given sufficient time interval to go through the natural cycle of action. In other words, if the first test fails the sear may not have sufficient time to move under the hammer, thereby producing a follow down.

Cock the hammer and then test the safety grip by pressing the trigger while allowing the grip safety to remain free. The hammer should not fall. If it does, the grip safety is defective.

Cock the hammer and put the thumb safety in the "safe" position, and then try to snap the hammer. If the hammer can be snapped with the safety on, or if the safety moves to the off position when the trigger is pulled, the safety is defective.

With the Government Model .45, the Super .38, the Ace .22, and other models in which the gun should remain open after the last shot is fired, put the empty magazine in place, draw the slide all the way to the rear, and release it. The gun should remain open. Press the slide stop downward. The slide should snap shut, and the gun should remain cocked.

Remove the magazine, grasp the gun firmly around the stock and grip safety with the right hand. Hold the trigger back, and with the left hand draw the slide back to the full extent of its rearward travel and let it snap forward smartly. Repeat this several times. The hammer should remain cocked until the trigger is released and again pulled. If the hammer follows the slide in this test, it shows that either the hammer or the sear is defective. This trouble is often caused by an attempt to reduce the trigger pull. If the trigger pull is reduced to too low a point, the hammer jars off when the slide slams shut.

Many pocket model automatic pistols are provided with what is called a magazine safety, which prevents a pull on the trigger from discharging the gun when the magazine is removed. This is to prevent accidents caused by the supposition of inexperienced persons that the removal of the magazine will unload the gun, when in reality a cartridge still remains in the magazine. Test for the presence and proper functioning of this safety by drawing back the slide and allowing it to go forward again, thus cocking the gun. Then remove the magazine and pull the trigger. The gun should not snap. Replace the magazine and again pull the trigger. This time the gun should snap.

Examine the lips of the magazine. They should appear well formed and in good order, without any cracks in the corners, or any signs of deformation.

It goes without saying that before starting to make any of the above described tests, the arm should be carefully examined to be sure that it is unloaded, and that all safety precautions should be observed. Particular care must be observed with automatics, where the magazine may be empty and an unsuspected cartridge may still be in the chamber.

All these tests will help greatly in giving the intending purchaser an idea of the condition of the gun, but the real proof of the pudding is in the eating, so try to get an opportunity to test the gun by actual firing with service ammunition if it is at all possible. This is particularly desirable in the case of an automatic pistol; malfunctions may be caused by things that are almost impossible to detect by visual examination, such as slight deformations of the magazine lips.

Proof Marks

Great Britain and many other countries prohibit the sale of firearms that have not been examined and tested by a recognized authority according to certain rules, and stamped with a mark to indicate that they are safe for sale and use by the public.

These proof marks form a very valuable indication as to the origin of an arm, because all arms made and sold in certain countries must be proved and stamped with the proof mark, even if the maker does not have confidence enough in his products to put his own name and address on them.

Apparently the practice of proving firearms started just about three hundred years ago, in 1637, when a royal charter was granted to the gunmakers guild of London, authorizing them to test and approve all firearms. This guild later became known as "The

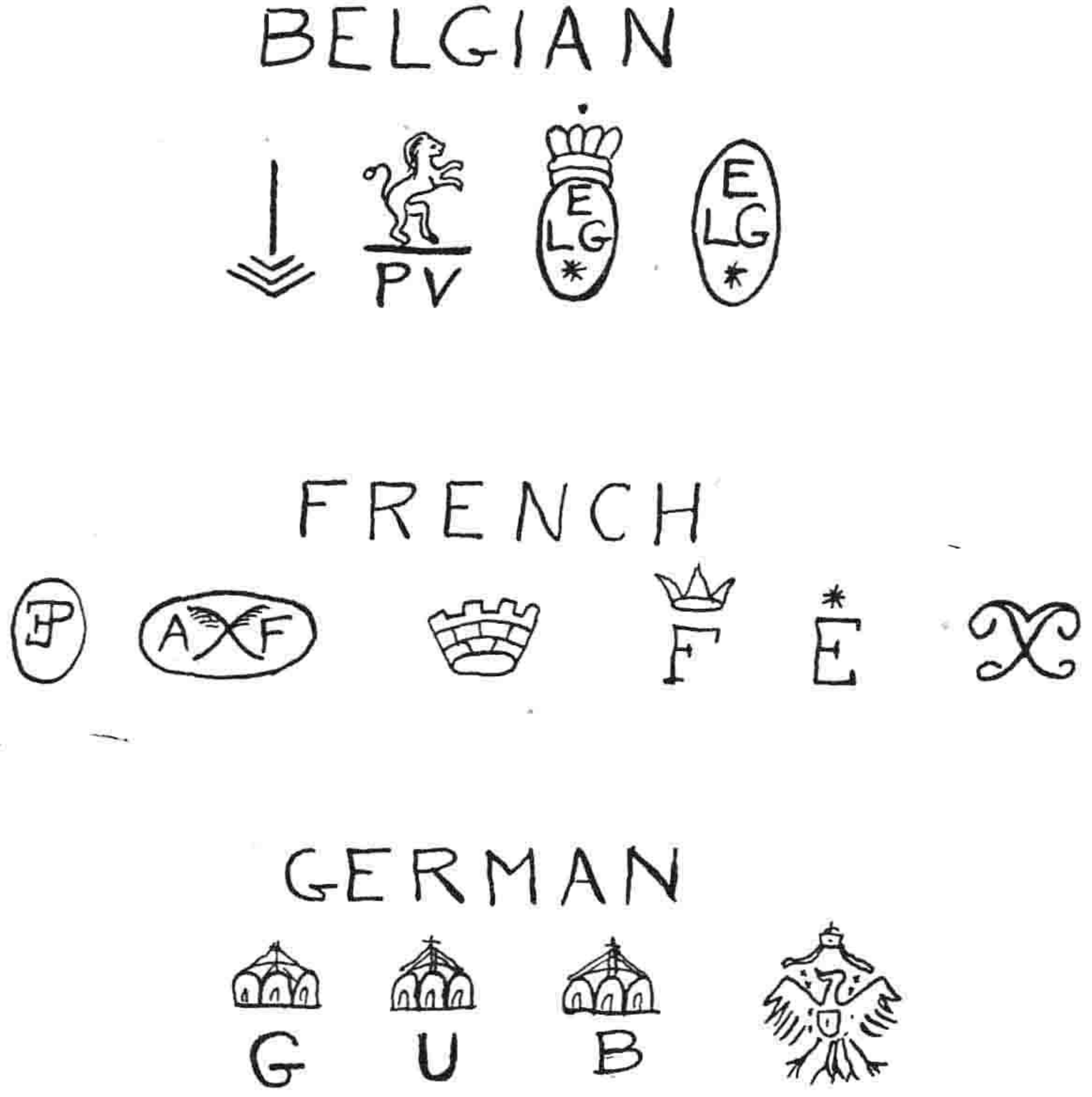
Gunmakers Company," and at the present time continues to test and approve, under carefully drawn specifications and regulations, firearms intended to be sold in the British Empire, whether they be of British or of foreign make. A similar organization called "The Guardians" is located at Birmingham, which, like London, is an important arms making center.

All firearms are carefully inspected to see that the design of the mechanism is satisfactory, that the parts are of the proper tolerance and are assembled correctly, and that the mechanism will operate safely. This operation is called "viewing" and when a gun passes this test it is said to have been "viewed," and is marked with a cipher stamp and the letter "V." Then when the gun has been tested by actually firing heavy charges to test its strength, it is said to have been proved, and is marked with the letter "P." "V P" so often seen on arms either alone or in combination with other letters or symbols means "Viewed and Proved."

The United States does not require the proving of guns prior to sale, but as guns that are not proved according to specified regulations cannot be sold in some countries, nearly all American arms makers have a proof test conforming to the British regulations to which they submit all arms intended for export. Some makers, notably the Winchester Repeating Arms Company and the Colt's Patent Firearms Mfg. Co. prove all guns made. American guns when submitted to a proof test are marked by the maker with a stamp to indicate that a proof test has been made. There is no uniformity about these marks, as they are designed by each maker to suit his own ideas. This is quite different from the system prevailing in most foreign countries, where the marks to be used are often prescribed by law.

The proving of any firearm usually involves the firing of the gun with a much heavier charge of powder than that used in service, with the idea of being certain that the barrel is strong enough to stand the specified charge, and hence will be safe to use.

There are two main kinds of proof, Provisional Proof, and Definitive Proof. When gun barrels are first made up in the rough, they are clamped to a testing device and fired with a heavy charge of powder to see if they are strong enough to be finished and assembled into a gun. This is the "Provisional Proof," and a certain stamp is placed on barrels so tested. After the gun is finally completed, it is again fired with a heavy charge to insure that the finished barrel and its breech mechanism have a factor of safety to insure against accident. This is the "Definitive Proof," and guns passing this test are stamped with still another mark. In the early years of gunmaking all proving was done with black powder, but in later years, after the advent of smokeless powders, it became necessary to change the tests to include these more powerful propellants, and several of the proof houses adopted a special mark for the provisional and definitive proofs with smokeless, or, as it was often called, "nitro" powder.



SOME PROOF-MARKS.

Countries having established proof houses include Austria, Belgium, Czecho-Slovakia, France, Germany, Great Britain, Hungary, Italy, and Spain. Belgium is a great center for the manufacture of arms, and one of the most famous proof houses in the world is that of Liège, Belgium.

The common Belgian proof marks are an oval, containing the letters "ELG" and a star, or the same design surmounted by a crown; also the figure of the "perron" or monument of the city of Liège, an obelisk or tower on a terraced foundation, which, when roughly stamped on a gun, simply looks like a vertical line with three V-shaped marks under it. In the Belgian, French, and many other proof marks the letter "E," meaning "Epreuve," or proof, occurs, generally in combination with the initials of a town —as for example the E—LG mentioned above, meaning the proof of the city of Liège.

These Belgian proof marks are often found on guns that would not otherwise be suspected of being of Belgian manufacture. For example, I once had a man offer to sell me a supposed dueling pistol with a Damascus barrel, said to be of Italian origin. On close examination, the Damascus barrel seemed to be imitation, and on the breech of it was found the telltale oval with the letters "ELG," the Liège proof mark. This was apparently an imitation made up for the antique trade, but had to be proof-fired under the Belgian laws, and the proof mark remained there to tell the careful observer the origin of the gun. Again, I was once shown a large-size flint-lock pistol. The lock seemed too big for a pistol lock and looked more like a musket lock. It was marked "Royal Manufactury of St. Etienne." I looked on the breech of the barrel for proof marks and did not find any, so I took the barrel out of the stock and on the underneath part found two Belgian proof marks, also a slot for the rear sight. These supposed flint-lock pistols had simply been made up also for the antique trade by taking a number of old junk guns, removing the locks from some and barrels from others, cutting off the barrels and fitting the lock and barrel to a stock made of plain ordinary pine wood varnished over to look like walnut.

CHAPTER 6

ACCESSORIES

WHILE the pistol or revolver as purchased will shoot satisfactorily with no additional material other than the necessary ammunition, every owner of a hand arm will find that whether his gun is to be used for hunting, for target practice, or for home protection, there will be certain accessories that he will want in order that he may get the greatest satisfaction and benefit from the use of his gun, and in order that he may use it most conveniently.

Holsters

Perhaps the most important accessory of all is the holster, which is a leather scabbard used for the purpose of carrying the gun on the person.

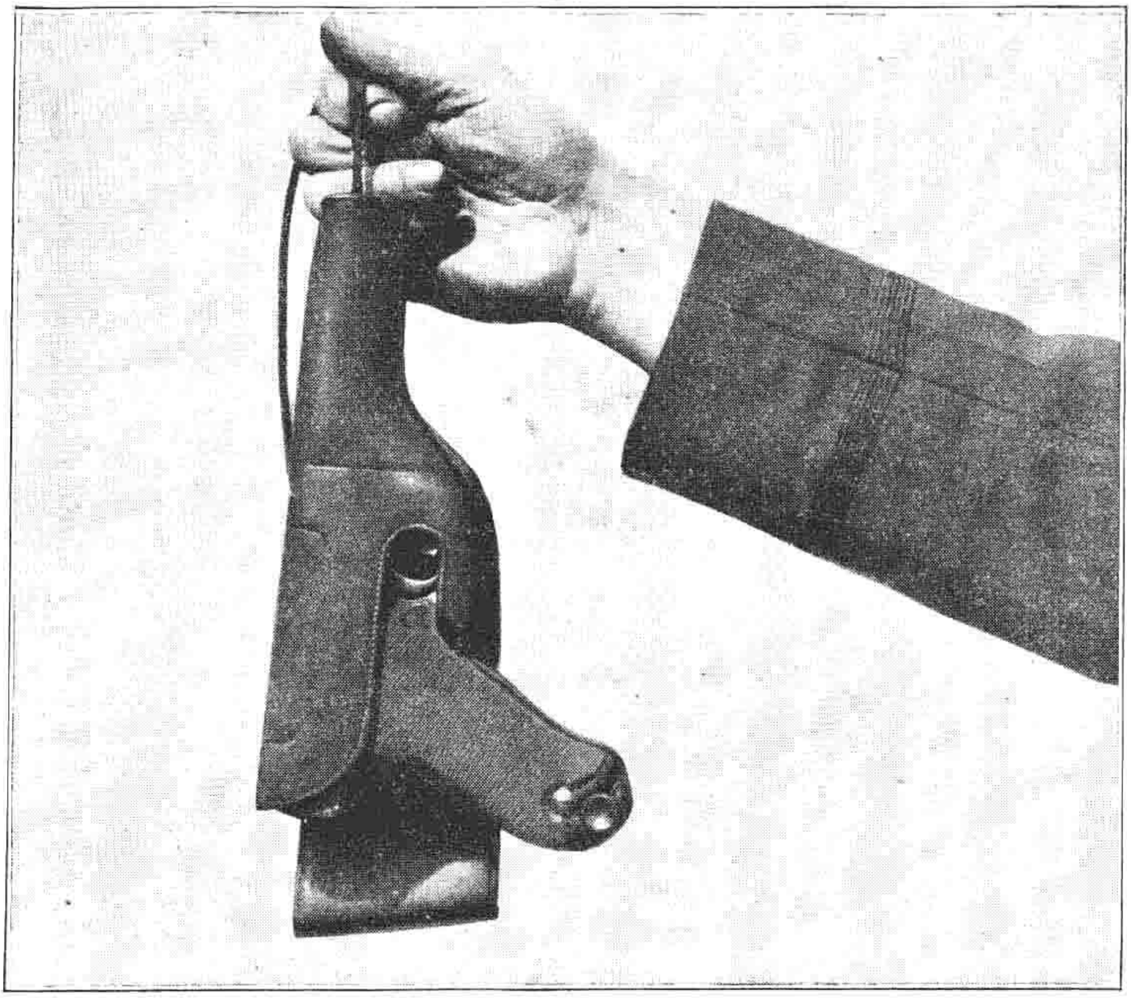
Most holsters are worn on the belt; though a type of holster which is suspended from the shoulder has become increasingly popular in late years.

Although in some parts of the country the use of a belt holster for carrying a revolver or pistol may give the user a "Wild-West" appearance and make him feel that it is cause for comment from onlookers, it is by all means the safest and most sensible method of carrying a hand gun, either on the range or in the woods.

Any hand firearm is a dangerous weapon, and when not being fired should not be left lying around. Onlookers and strangers have a provoking habit of picking up pistols and aiming or manipulating them without the owner's consent. While a loaded pistol should never be laid down for a moment when others are about, it often happens that a shooter must stop his firing for a few minutes or is interrupted in his score and must leave the firing-point for some purpose. A loaded gun can be slipped into the holster and is absolutely safe as long as it remains there.

Not only is the safety of others taken care of with the holster, but the gun is properly guarded also, from scratches, dents and knocks. Even if the gun is carried in a hand bag to and from the range, it is an advantage to slip it in a holster, which keeps it from rubbing on other articles in the bag, such as screw drivers, cleaning rods, etc.

A well made belt holster is a good investment and tends toward safe handling of the gun. It is well to get one about ½ inch longer than the barrel and closed at the bottom. This keeps dirt from getting into the muzzle in case the holster comes in contact with the ground. There should, however, be a drain hole near the bottom to let the water out in case of rain.



The Audley Spring Holster. The gun is securely held in place by a spring catch just inside the front of the trigger guard, yet it is easily and unconsciously released when the gun is grasped to withdraw it from the holster.

It is best to get a holster without a lining. One disadvantage of a lining is that it will sometimes wear through and catch on sights, etc. Another disadvantage is that sometimes the lining will collect moisture and rust the gun. For the same reason it is a good plan to avoid cheap holsters, as the leather sometimes has chemicals in it that will cause a gun to rust badly.

For belt use, the holster should be of the type that is cut out around the trigger guard, so that the finger can get onto the trigger at once. There must be some method of keeping the gun from falling out of the holster. In the open-top holsters, which form the quickest ones to get into action, the gun is retained by simply fitting tight when shoved down into place. Some open-top holsters have a strap going down over the top to hold the gun from bouncing out. This must, of course, be unfastened before the gun can be drawn and is the source of quite a delay where a gun may be needed instantly.

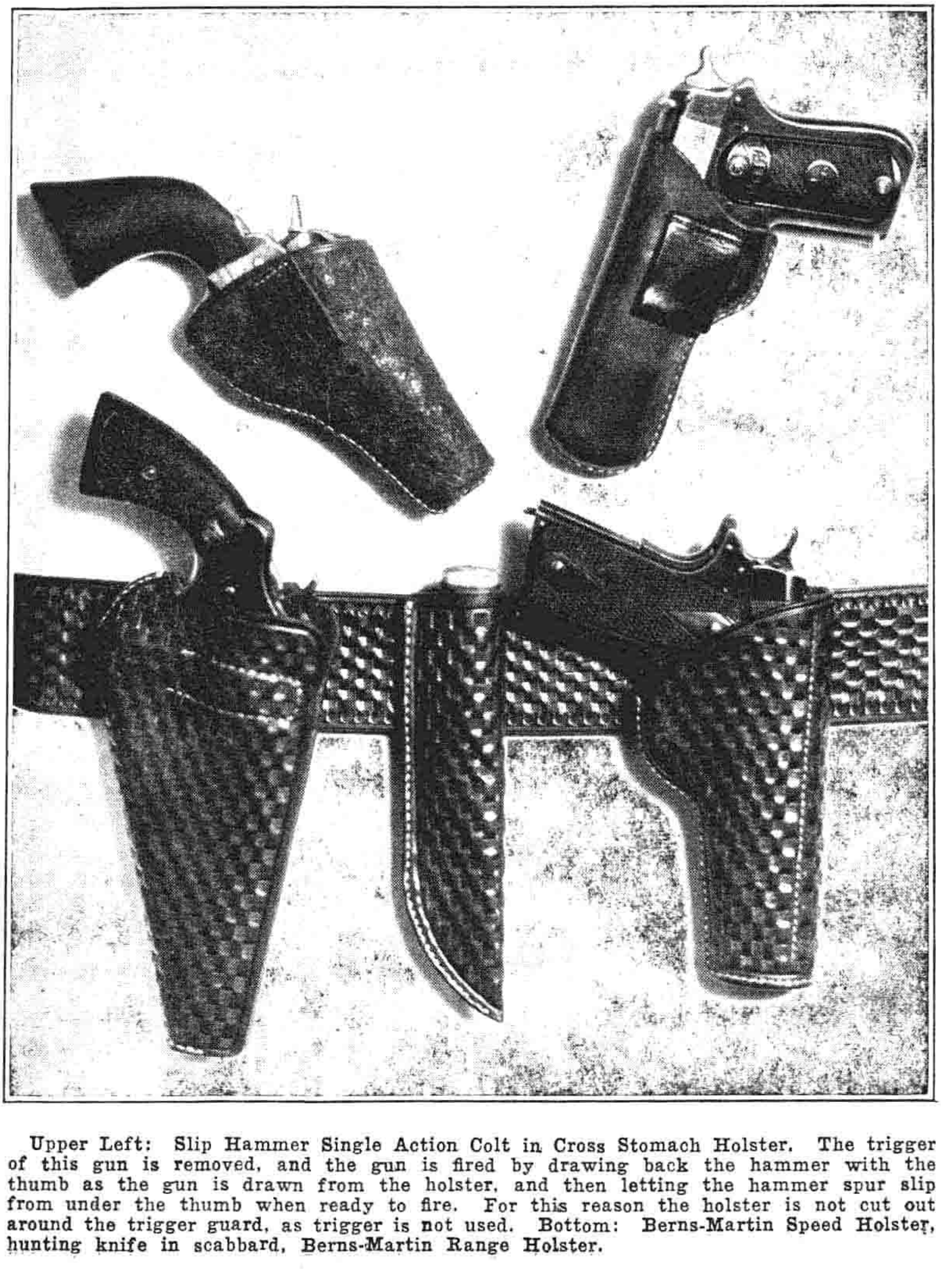
There is on the market a holster called the "Audley Spring Holster," which has a flat retaining spring which snaps into place in the trigger guard and keeps the gun from coming out of the holsters. These holsters are open top, with the leather cut away around the trigger guard. You can hold them upside down and shake them, and the gun will not fall out, yet the minute your finger goes into the trigger guard at all the flat spring holding the gun is unconsciously pushed out of the way, and the gun then comes out as though it were absolutely free.

A special purpose open top holster called the Berns-Martin Range Holster, made only for the Government Model .45 Automatic, the Colt Ace .22, and the Super .38 automatic pistol has two ribs of leather on the inside of the front of the holster, so arranged as to form a protecting slot for the front sight, which keeps the gun from rubbing on the leather when the gun is being put into or taken out of the holster, or when it is being carried. Thus when the sight has been blacked for range use, it will remain in proper condition, without having the black rubbed off.

The type of holster with a flap on top to protect the gun is desirable when the weapon is to be carried habitually. The flap should be held down by a slot or buttonhole in it, which fits over a stud in the side of the holster. The holster should be well cut away around the trigger. Most holsters as they are now sold are not sufficiently cut away at this point, but the user can always cut them away for himself.

In making a quick draw the hand is swung up from below, striking the projecting lower part of the flap and disengaging it from the button; at the same time the last three fingers of the hand grasp the stock of the weapon and the forefinger goes on the trigger, with the thumb on the hammer, cocking the gun as it is withdrawn. It is remarkable how little extra time it takes to disengage the flap in this way when you have practiced at it and gotten the flap worked in so that it slips off the stud easily. Just one upward motion of the hand disengages the flap and brings the gun from the holster cocked.

A belt holster suspended from the belt, or worn loosely on the belt should always be tied down at the bottom, as otherwise the holster will follow when an attempt is made to lift the gun out, and a quick draw is impossible. Many holsters have rawhide or



Upper Left: Slip Hammer Single Action Colt in Cross Stomach Holster. The trigger of this gun is removed, and the gun is fired by drawing back the hammer with the thumb as the gun is drawn from the holster, and then letting the hammer spur slip from under the thumb when ready to fire. For this reason the holster is not cut out around the trigger guard, as trigger is not used. **Bottom:** Berns-Martin Speed Holster, hunting knife in scabbard, Berns-Martin Range Holster.

buckskin thongs attached for this purpose. The regulation army holster has a strap to go around the leg and fasten with a buckle.

When a very stiff wide belt is worn, on which the holster fits tightly, it is not necessary to tie down the bottom, as the stiffness of the belt will keep the holster in place in making the draw.

An excellent holster, made for revolvers only, and especially designed for the fastest possible draw, which holds the gun securely under all conditions and at the same time gives it full protection is the Berns-Martin Speed holster invented and manufactured by two former Navy men, John E. Berns and J. H. Martin, of Bremerton, Washington.

This holster is open down the front, and the gun is held in place by a leather covered steel spring which clasps the cylinder. The top of the holster fits over the trigger guard, so that the gun cannot rise or be pulled straight up; it must be swung forward to release it from the holster. This feature is a good one, for it makes it impossible for anyone approaching from behind to disarm the wearer.

The material and workmanship on these Berns-Martin Holsters is of the very highest grade, and these holsters are made to order only, and fitted carefully to the particular gun for which they are ordered. They are not made for automatics.

Part of the outfit is the big wide stiff belt which just fits the slide in the holster, so that when the holster is on the belt, it is impossible to tip the holster or lift it up in making the draw. These holsters are made to be worn on the right side for a right hand draw; and they are made either for wear low on the right side of the leg or waist high just forward of the hip pocket. The high position is recommended as being the more practical.

When practicing at quick draw work with the speed holster, the beginner should, in his first attempts, draw slowly, grasping the butt of the gun with the last three fingers, extending the index finger downward and placing the thumb on the hammer. Avoid any tendency to lift upward. Pivot the gun forward and downward, allowing the muzzle to rest on its plug until the cylinder is clear of the retaining spring. The gun should be cocked at the same time. Then toss the gun upward while the thumb falls into place at the side of the frame and the index finger engages the trigger.

Those who from years of use of an ordinary open top holster have acquired the habit of lifting the gun during the draw, can overcome this tendency by exerting a definite downward pressure on grasping the gun. This downward pressure practiced with the tipping forward process described above will soon develop a smooth, clean draw. Speed will come in a surprisingly short time with intelligent practise, and when it has been attained, it will be found that both the downward pressure and the tipping forward or slight pivoting motion will be performed unconsciously and so swiftly that neither will be noticed.

Double action revolvers may, of course, be drawn and fired without cocking by the thumb if for any reason the double action method of shooting is preferred.

If desired, a safety strap is furnished with these holsters; but they are so carefully fitted to the gun they are to hold that the strap is entirely unnecessary, and should be left off. However, when it is fitted it is made with a generous extension of strap beyond the snap-fastener, so that it can be unsnapped very quickly with a sharp forward stroke of the hand.

The Berns-Martin Speed Holster was built primarily to be the fastest possible holster on the draw, but it has advantages even when the owner is not interested in exceptional speed. It is particularly practical for long barreled guns, as they can be drawn as quickly as very short guns. Sights do not come into contact with the leather, and so will not wear bright, and sights which have been blackened for use on the pistol range will not have the blackening rubbed off.

Shoulder holsters which hang from the left shoulder so that the gun is carried under the arm are very popular. They have the great advantage that the gun is entirely out of sight and not noticeable when the coat is worn.

There are two kinds of shoulder holster; the pouch holster in which the gun slides down in to the holster from the top, and comes out the same way; and the spring holster, which is open down the front and has a leather covered spring to clasp the cylinder of the revolver and hold it in place. To remove the gun from the holster, it is jerked downward and forward, pulling it from the grasp of the retaining spring.

The pouch shoulder holster is rather slow on the draw, as the gun must be raised very high to get it out. Otherwise, it is very satisfactory. The spring shoulder holster is very much quicker on the draw, but is not well adapted to carry automatic pistols, as the spring does not grasp the flat slide with the same security that it does the cylinder of a revolver. Many spring shoulder holsters for automatics are seen, but they are sold to those who have had no experience with them and do not realize how unsatisfactory they are. The design of a good shoulder holster is something that requires brains, knowledge, and experience in carrying a gun. Most shoulder holsters are poorly designed. Among the important points are the strength and shape of the retaining spring. It should fit the cylinder securely enough to prevent all danger of having the gun fall from the holster when the wearer stoops over, or in any other conceivable circumstance yet it should be flexible enough to release the gun easily when it is pulled smartly forward.

Most shoulder holsters seen in stores have too stiff a spring. In some that I have tried, it is almost impossible to pull the gun from the holster by a straight forward pull. Again, many of these holsters are made so that they carry the gun too high, so that it bulges out to one side. The holster should be of such length that the gun is carried with the cylinder resting right in the hollow of the waist, where there is most room for it to lie without pushing the coat out from the body. To give the best results, the spring shoulder holster should be designed and made specifically for a given model of revolver with a given barrel length, and these particulars should be required by the maker when the order is received. A very fine spring shoulder holster is the one designed by Mr. Wm. T. Smith, of the Police Department of Edw. K. Tryon & Co., 910 Chestnut St., Philadelphia, from whom these holsters may be ordered for a very reasonable price.

A good way to carry a small revolver unobtrusively, and at the same time in such a manner that it can be drawn with the maximum of speed, is in an open top belt holster worn in front of the abdomen on the opposite side from the hand with which the gun is to be drawn. The gun is thus concealed under the coat and vest, but can be drawn with lightning like rapidity by lifting up the edge of the vest with the left hand and at the same time grasping the gun with the right. This is called the "cross-stomach" draw.

Carrying Cases

The target shot will often have to carry his guns back and forth from his home to the range or club, which most often is located in a town or city, and obviously he must have some receptacle for his guns and ammunition during these trips, for a revolver or pistol cannot be carried in the hands through the streets.

Occasionally this problem may be solved at the time of the purchase of the weapon by the fact that several makers furnish cases for certain of their target arms, usually at an extra cost. For example, the Smith & Wesson Straight Line Pistol comes in a pressed steel case with a cleaning rod and a screw driver. Harrington & Richardson furnish an excellent carrying case for their U. S. R. A. Model pistol at an extra cost. This is a little trunk with a carrying handle on top, containing space for the pistol and ammunition, and the cleaning rod and cleaning materials as well. The gun is held in place by a strap around the barrel so that the sights cannot touch anything. This not only protects the sights from injury, or from wearing bright, but also allows them to be smoked or blacked with the assurance that the blackening will not be rubbed off.

Recently, (1934) the Hartmann Trunk Company, in collaboration with the National Rifle Association of America, designed two pistol carrying cases of different sizes that are ideal for the target shot.

These N. R. A.-Hartmann pistol cases are constructed just like the standard luggage regularly made by the Hartmann Trunk Company for travellers. The body blocks and compartments are of basswood, with the corners dovetailed and strongly locked. A hard washable lining is used for the interior to promote cleanliness and minimize absorption. Holding blocks for the arms to be used are covered with handsome velour. The outside cover is a tough grained imitation leather, which is hide-glued permanently in place. There are two nickeled snap catches which may be locked with a key. Under the handle is a very handsome and distinctive N. R. A. name plate which bears a separate registration number for each case. It is a very attractive piece of equipment from a practical standpoint, and it is handsome no matter by what standard it may be judged.

The smaller sized case is 12¾ inches long, 9 inches high, and three inches thick. It has an ammunition compartment designed to fit a box of .45 or .38 special cartridges and several boxes of .22s. Another compartment contains two screw top bottles for small parts, cleaning oil, etc. There is also a compartment for any one of the three best Wollensak pistol telescopes in 15 power, 20 power, or 25 power. There are two sets of clips for cleaning rods, swabs, and brushes. The holding blocks are designed for two pistols and revolvers, one of them being held in an inverted position. This case will accommodate any standard revolver with 6½ inch barrel or the H. & R. 7-inch barrel single shot pistol.

The larger case is made expressly to carry a ten inch barrel target pistol together with a revolver with extra long barrel. It is made in the same way and with the same construction as the smaller case, but with slightly larger dimensions to agree with the greater capacity of the case. It is 15 inches long, 13 inches high and 3 inches thick. The telescope compartment is made expressly for the Bausch & Lomb N. R. A. Junior model draw-tube spotting scope. The ammunition compartment is also larger than the one in the smaller case.

In either of these cases, the guns and shooting equipment are all kept assembled together and securely protected, ready for a shoot or a trip at any time by merely picking up the case without having to remember to bring various articles from different places with the attendant risk of forgetting some of them.

For those shooters who do not desire to go to the trouble of providing themselves with a special pistol case, I want to call attention to the fact that the ordinary leather brief case will serve the same purpose fairly well. These cases are usually divided into three compartments by leather partitions; thus two or more guns may be carried in such a brief case without danger of their being marred from rubbing together. Targets, ammunition, cleaning rod and screw-driver may also be carried in the same case. While the brief case does very well, it has the disadvantage that everything gravitates to the bottom, and the guns are not held so that the sights are protected. On the other hand, an advantage is the fact that the brief case is not conspicuous, and no one would suppose that a gun was being carried, which is desirable, for a gun even in a case, always attracts notice and causes comment in the large cities.

Among the articles that should be carried in the shooting case are screwdrivers and cartridge blocks. A screwdriver to fit the screws of the adjustable sights on target pistols and revolvers is a necessity, and no user of a target pistol should go on the rifle range without the proper screwdriver for his gun, yet it is a fact that very often when a shooter finds it necessary to change his sights during a shoot, he holds up the entire proceedings and makes a nuisance of himself by going around from one to another of his fellow shooters trying to borrow a screwdriver, and as often as not finding that the one he can borrow is made to fit some other make of gun and will not go into the slots on the screws of his sights.

Cartridge blocks are simply pieces of wood with holes drilled in them for holding ten or twenty-five cartridges. In shooting a match with single shot pistols, the necessity of keeping a mental count of the number of shots fired is avoided by placing the correct number of cartridges in the block. Then when they are all gone, the right number has been fired. Some cartridge blocks made in the form of a little box of just the right size to hold two boxes of .22 caliber cartridges. The box has a sliding lid, with ten holes drilled in it, each hole being of the proper size to hold one .22 cartridge.

Another thing that should be in the shooting case of all pistol shooters who shoot outdoors is material for blackening the sights. The metal surface of the sights will shine in some lights, even if the metal is blued. This effect is particularly noticeable if the sights are oily, and is much worse when they have been worn shiny by rubbing on a holster, or from wear of any kind. In some lights it will be impossible to define the sights at all unless this shine is removed, and in any case, shooting outdoors is made much easier by taking away the glare and giving the sights a uniform dull black surface. This is ordinarily done by smoking the sights with a match, a candle, or a piece of camphor, which is excellent for giving a velvety black surface, or by painting them with a solution of lampblack in some very volatile fluid such as gasoline. Dealers in target shooting supplies sell sight blackening solution in a small bottle with a brush in the cork for a few cents. It is a very practical thing to carry such a bottle always in the shooting kit. Matches and a candle will give a better finish on the sights, but often on the range the wind will prevent their use, while the bottle of sight black will always work. It is not necessary to blacken the sights for indoor shooting, where nearly all the illumination comes from the target itself, for in this case the sights are like dark shadows silhouetted against a light background.

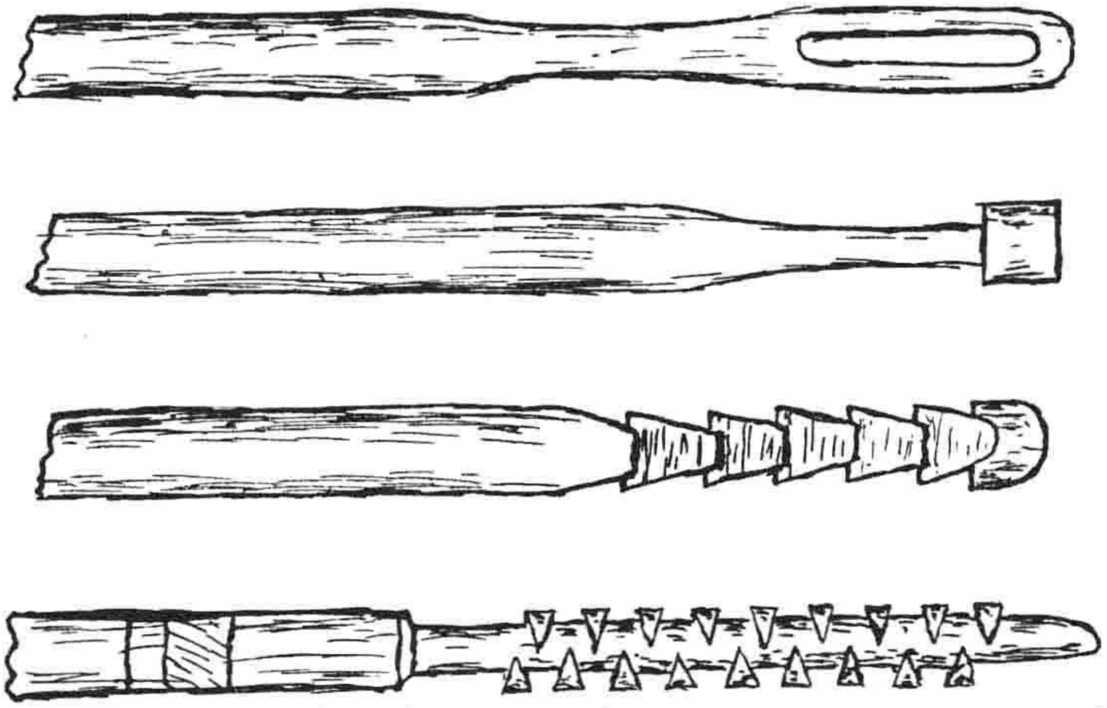
For indoor shooting with large caliber guns, some protection should always be provided for the ears, and while this protection is not essential outdoors, it is still desirable, for there is no use needlessly risking a permanent injury to the hearing. Ordinary absorbent cotton makes the best ear protector. There are a number of patent ear protectors on the market that work well, but they are no more effective than the cotton, and they are not as sanitary, as they are used over and over, while the cotton is used just once and then thrown away. A small roll of absorbent cotton which can be obtained from any druggist is all that is needed, and it should be in every shooting kit.

Cleaning Material

The most important single item of cleaning material is the cleaning rod, which is a steel, brass, or wooden rod used to carry a rag or cleaning patch with which the inside of the barrel is wiped out after shooting.

The cleaning rod must be of the proper size to fit the caliber of gun that it is to be used with. In other words, the .22 caliber cleaning rod is not suitable for cleaning the .38 or .45 caliber arms. However, when rods have detachable tips which screw on, a .32 or .38 caliber rod will do for cleaning larger caliber arms, provided the proper tip is used on the rod.

Every gun when sold has a cleaning rod of some kind packed with it, though usually these gift rods are next thing to useless. Generally they are simply a piece of wire with a slot in one end.



Common forms of cleaning rod. Top, the slotted rod, which is a poor shape for thorough cleaning, but is the most often seen because it is easy to use. Second, the button tipped rod. This is a good type, with much to commend it. Third, home-made rod constructed from No. 11 drill rod by filing four sets of teeth on the end. The teeth on two sides point back; these on the other two sides point forward. Bottom, the Parker Tru-form Jag, used with a special oblong patch which is rolled around the brass jag to form a tightly fitting cylinder of cloth which does an excellent job of cleaning.

A rag can be drawn through the slot and be used to swab out the barrel. Undoubtedly the use of a rag in a slotted cleaning rod is far better than no cleaning, for at least a coating of oil can be applied with it; but thorough and satisfactory cleaning can not be done with it. What is needed is a rod with a tip which nearly fits the barrel, and which will carry a canton flannel patch in such a manner that the patch will be pressed firmly against all parts of the bore as the tip of the rod passes through.

A common and very satisfactory form of cleaning rod is a steel or brass rod nearly as large as the bore, with a reduced diameter for a short space near the end, so that the end itself forms a button tip for holding a cloth patch. This and several other forms of cleaning rod are shown in the sketch.

With this button shaped tip, a round or square canton flannel or outing flannel patch is used, and the patch must be of such a size that it is just possible to force the rod into the barrel with no difficulty when the tip of the rod is covered with the patch. It is most important to get the patch the right size, for if it is too loose, it will not wipe the bore clean, and if it is too tight, there will be too much friction, and the rod may pierce the patch and become jammed.

The main disadvantage of the button tipped rod is the likelihood of having the rod pierce the patch and jam in the bore. If the rod is of brass, it may be difficult to remove, but will not harm the barrel, but if it is of steel, an attempt to remove it may cause the cloth to pile up under one side of the rod and jam there more tightly than ever, thus forcing the sharp edge of the button against the other side of the barrel, so that it will have a tendency to scrape. I have seen a barrel badly marred by such an accident, so if a steel rod becomes jammed in your barrel, use great care to avoid forcing it unduly.

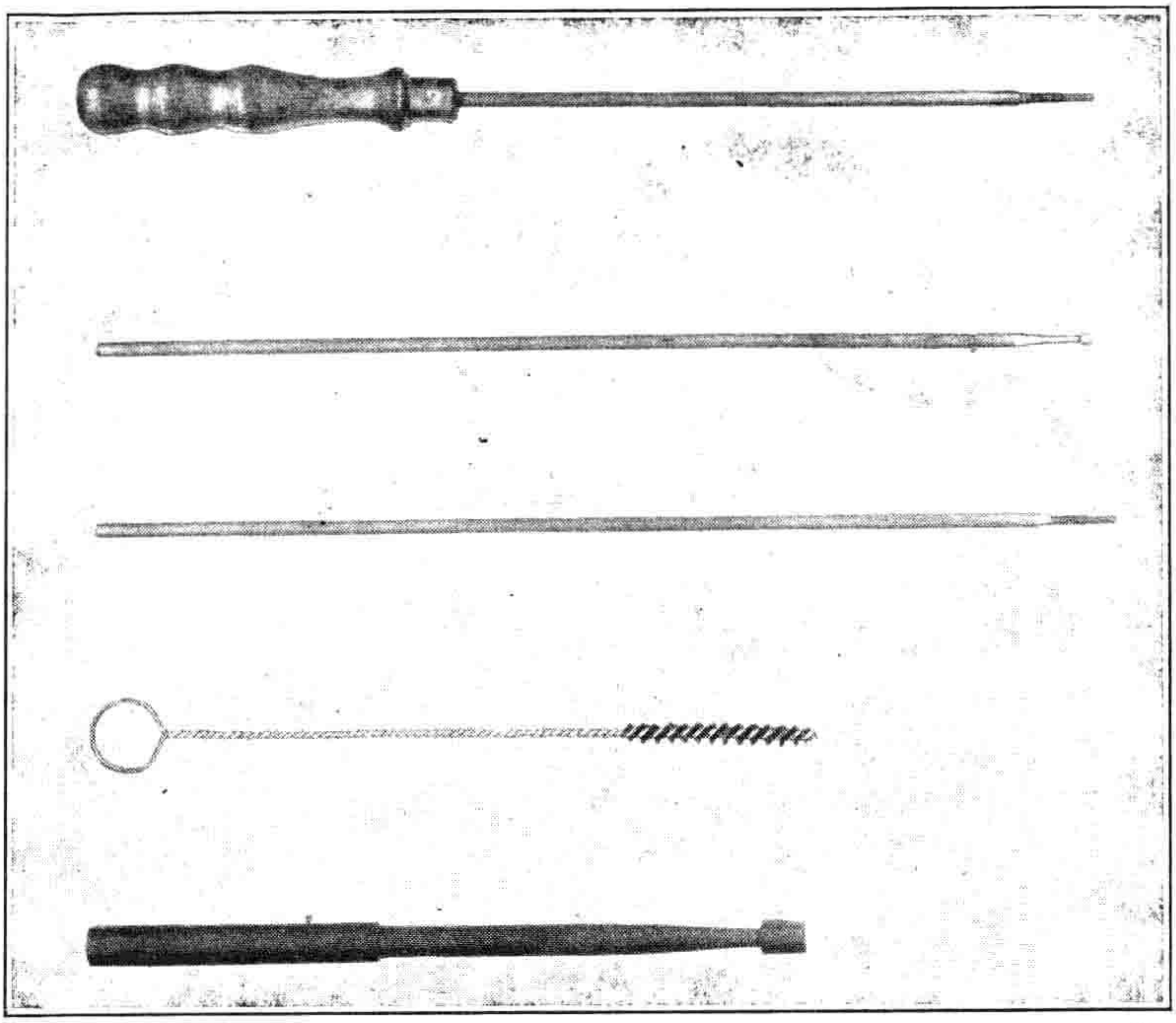
A very satisfactory home made cleaning rod that was much used in the Springfield Revolver Club at the time that I was a member of that organization consists of a piece of No. 11 drill rod, (which is .191 inch in diameter), with the end filed so as to make a number of saw-toothed notches, those on two sides pointing backwards, those on the other sides pointing forward. The extreme end is rounded. When an outing flannel patch one inch square is used with this rod, it is a snug fit, and will do an excellent job of cleaning. The saw teeth on the end of the rod hold the patch firmly in both directions, so that it can be scrubbed back and forth in the barrel as much as desired without coming off. The saw teeth cannot touch the rifling, for the rounded end of the rod in front of the teeth and the main body of the rod behind them are both higher than these teeth. The rod is fastened in a wooden handle, and is made just the right length so that it projects through the muzzle about a quarter of an inch when the handle strikes on the breech. Thus the rod cannot be pushed far enough through the barrel for the patch to come off, and with the barrel held firmly in a cleaning vise, the rod can be scrubbed back and forth through the entire length of the barrel without having to stop every time the rod goes through. I have bought most of the fancy cleaning rods on the market, but have never seen one any easier to use or more effective than this one.

Perhaps the best cleaning rods and attachments for them obtainable commercially are those made by A. G. Parker, Ltd., of Birmington, England. The rods are made in different calibers as desired, and are covered with a celluloid outer coating to prevent wear or injury to the barrel. The handles of the rods are made so that they can rotate, and are mounted on ball bearings so that the patch can follow the rifling when the rod is pushed through the barrel. Different styles of tip are furnished to screw on the end of the rod. A good style of tip is that known as Parker's Truform Jag. It is a brass rod with two sets of spiral grooves cut in it, the spirals being in opposite directions, so that the spaces between them form little raised diamonds of brass. To use this tip, specially made oblong patches of outing flannel sold by the makers of the rod are employed. When a patch is wrapped around the Truform Jag it makes a cylinder of cloth which just fills up the bore, and does an excellent job of cleaning. In the ordinary button tip rod, the patch is laid over the end of the rod, and then the outer portions or skirt of the patch have to fold over irregularly when the rod is pushed into the barrel. In this Parker Truform Jag the case is entirely different, for the patch does not go over the end of the rod at all but wraps around the jag in a neat cylinder which is just a tight fit in the bore.

Besides other styles of tip, there are various kinds of brush, of either bristle or brass wire that may be obtained to screw on to the Parker Rods. Wool mops or swabs for greasing may also be obtained. Altogether these Parker rods and their attachments are to be highly recommended, as everything needed for cleaning the gun, removing lead, oiling or greasing, etc., can be obtained in one outfit and at a very reasonable price.

As mentioned above, the size of the canton flannel or outing flannel patches used is very important, and when the Parker Rods and jags are used, it is extremely convenient to purchase the patches ready cut. These Parker accessories may be purchased from several large dealers in target practice material in this country, such as for example, P. J. O'Hare of Maplewood, N. J., who stocks nearly every shooting accessory that is used at all, whether it is made in America or abroad.

Besides ready cut patches for rods such as the Parker, it is well for the shooter to keep on hand a yard or so of outing flannel for use in making up patches when odd sizes are needed for special purposes. It is also very good to use for wiping cloths to remove perspiration. A small square of outing flannel into which a little light oil has been rubbed should be kept in a glass jar for use in wiping guns before laying them away. This will remove perspiration and will deposit a film of oil on the guns which will preserve the finish and prevent rust.



Cleaning Rods. Upper, Jointed rod for .22 rifle. Middle, bristle brush, which is useful for hasty cleaning with nitro-solvent. Bottom, Bair cleaning rod made of walnut. This rod is excellent for thorough cleaning, when used with a patch of the proper size. It is made in various calibers, the one shown being for the .45 automatic. The length of the rod is such that the patch can be pushed just to the end of the barrel, but not all the way through. This makes it easy to clean thoroughly by scrubbing backwards and forwards.

In cutting patches from outing flannel or canton flannel, it is well to remember that the proper size for the patch to make it fit the cleaning rod correctly will depend on the thickness of the cloth. A thicker cloth will have to be cut into smaller patches, and if the cloth is thinner, the patches must be made larger.

Brushes of various kinds are indispensible for the proper and convenient care of firearms. Bristle brushes are useful for scrubbing out the barrel with nitro-solvent, chloroil, or the like, before using patches. They are also useful for applying grease to the inside of the barrel and cylinder, and to various corners such as the part of the frame just forward of the cylinder, where the rear end of the barrel projects through. There are little cracks at such points that are very difficult to be sure of reaching with a greasy cloth, whereas just one stroke of the brush will reach the most difficult parts.

Brass wire brushes are extremely useful for removing lead and also for loosening and removing rust spots. A brass brush will not scratch the barrel, for the metal of the brush is softer than the steel of which the barrel is made.

All gunsmiths have steel wire brushes of various calibers which are a tight fit inside the bore of the gun. They are used to remove rust, etc., from badly corroded barrels that are in such bad shape that a brass brush is not effective. When there is a bad rust spot in a barrel that resists efforts to remove it, put the barrel in a vise, run a threaded cleaning rod all the way through it, and then screw on a steel brush and draw in through the barrel just once, or in very bad cases unscrew the brush after it comes through and repeat this operation several times.

Very great moderation and care must be used in the use of the steel brush, as the bristles are just as hard as the material of the barrel, and a barrel can be very badly scratched by the careless or excessive use of a steel brush. The reason for pulling it through instead of pushing, is that in pushing the brush has a tendency to buckle up when resistence is encountered, and this buckling action has a tendency to make the bristles stick into the steel and thus scratch; whereas if the brush is pulled through, the bristles slant back in the direction from which they came and drag over the surface without any tendency to stick in. For the same reason, a steel brush should not be scrubbed back and forth, or used with a reciprocating motion, as the bristles which had slanted back due to the forward pull would catch in the metal and scratch as soon as the motion were reversed.

Shooting Glasses

Shooters with defective vision will naturally do better shooting if they are properly fitted with glasses by a qualified oculist; but quite aside from the question of defective eyesight, glasses of various kinds for protecting the eyes as well as for permitting the target to be more clearly seen in certain lights are very useful.

As for the question of protection, shooting glasses are a factor of safety in shooting any kind of weapon, but especially a high powered rifle, for occasionally the firing pin will puncture the primer and some gas under high pressure will escape to the rear, and this usually is very painful to the shooter's eye. Then again, in pistol shooting the head of a rim fire cartridge may burst and allow gas to escape in the same way. While this is not so dangerous with the pistol as it is with the rifle, because the pistol shooter's eyes are further away, protection to the eyes gives a very comfortable feeling of assurance, and sometimes results in bettering the scores through the removal of a possible cause of flinching.

This is even more important when a revolver is being used, and especially if others on the same firing line are also using revolvers, for if the cylinders do not line up correctly, shaving of lead may result from failure of the bullets to enter the barrel squarely. This shaving of lead may cause fine particles to fly back into the faces of shooters on the firing line. I have known a spectator at Camp Perry who was standing six feet back of the firing line to be quite sharply stung by particles thrown off by a newly designed model revolver which the manufacturer had brought to the range for a tryout.

Then there is the question of bright glaring light as found on some rifle and pistol ranges. Shooting in very glaring lights is hard on the eyes, as it causes the pupils to become contracted and renders it difficult to see the sights and the bull's-eye clearly and in detail. It may also give the shooter a headache.

For these reasons every shooter should be equipped with a pair of tinted glasses that will cut down the glare; and in order to furnish the maximum of protection from both the light and from foreign materials, these glasses should be of large size. There are a large number of different kinds of shooting glasses to choose from. King's "Rifleite" glasses may be mentioned as having very remarkable qualities. They have a brilliant yellow color that has the peculiarity of making the black of the bull's-eye seem even blacker and more clearly visible, while still protecting the eye from excessive glare. The reason for this is that the color in the glass cuts down the volume of the light that gets through; but at the same time what it does let through is the part of the spectrum to which the eye is most sensitive; in other words, in which the visibility is the greatest. It is a peculiar thing that if these glasses are put on in the deep dusk, things are seen as easily as without them; they do not reduce the visibility. But approaching automobile headlights lose much of their glare when viewed through these glasses. For this reason I find them of even greater use for driving an automobile at night than for shooting.

These glasses may be obtained either plain or with a prescription ground into the lenses. It goes without saying that if the intending purchaser of a pair of these glasses has any defect of eyesight, he should have his own prescription ground into the lenses. Like the other accessories mentioned in this book, these glasses may be obtained from the dealers in shooter's supplies.

Orthoptic Discs

The orthoptic sight is the name given to the rear sight with a disc having a small hole in the center through which the sighting is done. In target shooting circles the name "orthoptic disc," "orthoptic spectacles," etc., is given to such discs worn on the spectacles or near the eye of the shooter, without being actually attached to the gun as is a peep sight.

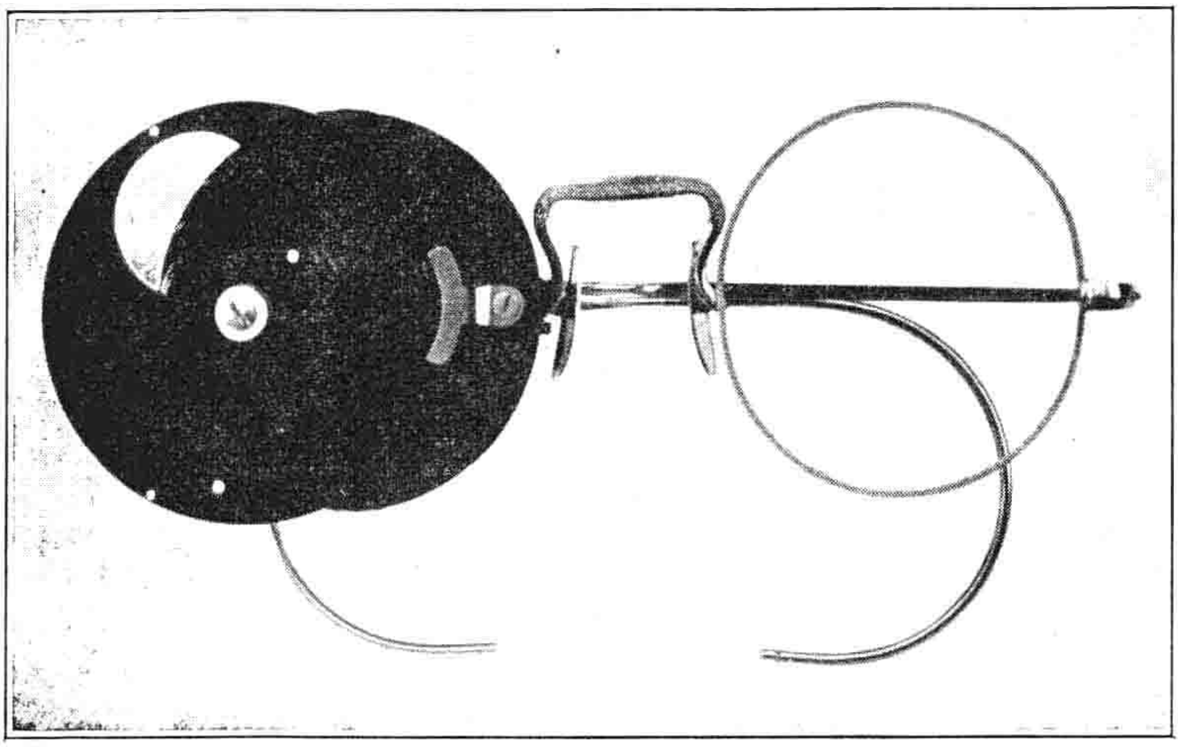
Devices of this nature have been becoming more and more used in the last few years. They are based on the optical principle that it is much easier for the eye to accommodate itself to different distances if the field of view is restricted to a small pencil of rays where not much correction is needed, just the same as a camera has much sharper definition for different distances when a small stop or diaphragm is used.

When a pistol shooter aims at the target, he makes an effort to see three objects at the same time which are at different distances; namely, the rear sight, the front sight, and the bull's-eye. This is an impossibility, for when the eye is focussed properly for the bull's-eye twenty yards away, it cannot see the sights clearly; and when it is focussed for the front sight three feet from the eye, it will not be able to see clearly the rear sight ten inches closer, for as the distance from the eye diminishes, the accommodation required becomes increasingly difficult, so that there is almost as much change in focus between the rear sight and the front sight as there is between the front sight and the target.

What the eye actually does in this case is to focus first on one of these three points, then on another, so that the attention of the mind and the focus of the eyes is constantly shifting from one sight to the other and to the target, and then back again. These changes occur unconsciously and with such rapidity that the shooter thinks he sees all three points at the same time; but this is an illusion caused by the rapidity with which the action takes place.

As the eye ages, its ability for rapid changes in accommodation diminishes, and it gets harder and harder for the shooter to see the sights and the bull's-eye clearly; but by placing a diaphragm with a small hole in it in front of the eye so as to cut out all but a small pencil of rays, this condition is remedied, and both the bull's-eye and the sights can be seen more clearly, and the amount of accommodation required of the eye is reduced.

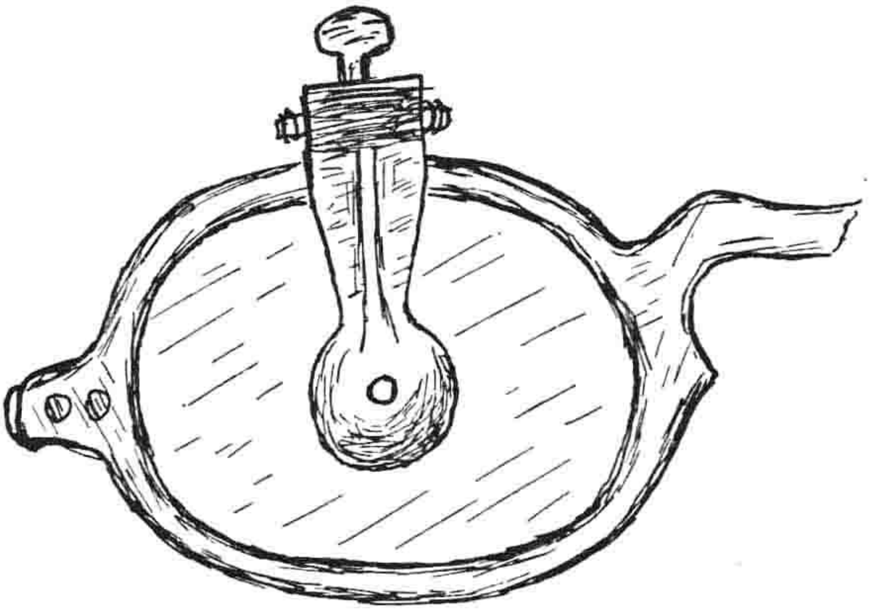
Devices for this purpose take various forms, to suit the ideas and personal convenience of the user, or of the designers or makers of such articles for sale. Some years ago Mr. Paul Van Asbroek of Holland, twice winner of the International Pistol Matches for the Championship of the World, who was at that time more than 60 years old, was using a disc with a pinhole in it suspended from his hatband so that it hung in front of his shooting eye. Other well known shooters have suspended a disc from the hatband. At the Eastern Smallbore Tournament at Camp Ritchie, Maryland, in the summer of 1934, Mr. Ray Bracken of Columbus, Ohio, was using a very simple and effective device of this kind consisting of a small black celluloid disc about an inch in diameter with a clip to fit over the top of a spectacle frame. A hole about .05 inch in diameter is drilled in this disc, to coin-



The Universal Aperture Spectacle. The revolving disc attached to the shield covering the right eye contains several small holes in different positions, to accommodate different positions of shooting. **By sighting through one of these holes, marksmen with failing eyesight are enabled to see both the sights and the target clearly.**

cide in location or align with the pupil of the sighting eye when aiming. Any optometrist or optician should be able to supply these optical shields from stock for a very small sum.

There is a very carefully designed and well made appliance of this nature on the market, which is sold by the designer, Henry P. Jones, M. E., of Burlington, Vermont. It consists of a pair of spectacle frames without glass, together with a blank metal disc which fastens on either right or left eye-frame by means of clips. This disc has a large aperture, ¾ of an inch in diameter in the center; mounted on this disc so that it can be rotated is a second disc, which has not only a ¾ inch aperture, like the first disc, but also several .05 inch holes in different locations. When the two large holes are together, the shooter can see as though he did not have the appliance on. It is worn this way for walking around the range, loading, scoring targets, etc.; but when the user is ready to commence shooting, a quarter of a turn of the overlapping disc brings one of the small holes over the pupil of the eye, and the only view that can be had is through this small hole, which sharpens up the images of both sights and of the bull's-eye until they can all be seen clearly. As remarked above, the overlapping disc has several of the small holes in it, in different locations for different uses. The one nearest the center is used for pistol shooting; but when shooting the rifle prone, a hole is brought into position which is near the edge of the frame,



Wright's Eyesight Compensator. This device consists of a cup-shaped disc of sheet metal fitted with a spring clip to attach it to the rim of the user's spectacles. This small hole through which the sights are viewed acts like the diaphragm of a camera lens and clears up the image of the sights and bull's-eye.

at the top. This appliance works very successfully, and is a wonderful help to the shooter whose eyes have lost part of their accommodation.

Another attachment to the eyeglasses for the same purpose is Wright's Eye-sight Compensator, made and sold by W. A. Wright of 1223 Lifur Ave., Los Angeles. It is a little cup-shaped disc of metal with a .05 inch hole in the center, and a clip on one side to fit over the edge of the eye-glass frame. This device does not take up the entire eye-glass lens, but covers only a part of it, so that the user can see quite well with it in place by looking around instead of through it. When both eyes are used in walking around, etc., the user is hardly aware that the device is on his glasses; but when he raises his gun to aim, it is in place, ready to use.

Telescopes

Another optical aid to the target shooter is the spotting telescope. During the progress of a match, the only way the shooter can know what he is doing and where his shots are going and how they are grouping is by inspecting his target from time to time by the aid of a range telescope.

A glass for this use must be of sufficient power and definition to clearly show .22 caliber bullet holes at 50 yards. A suitable telescope, magnifying objects twenty times, is the new Wollensak Spotting Telescope, which retails for the very reasonable sum of $10.50. The 15 power scope, which is also very satisfactory sells for $8.50.

Bausch & Lomb have designed a rifle range telescope called the N.R.A. Model, which gives excellent definition and a beautiful wide field of view. It is a prismatic telescope, which is made short and compact, as it does not draw out as do the non-prismatic glasses. It will give beautiful results on either the rifle range or the pistol range, but it is a better and more expensive glass than is necessary for pistol work alone. The rifleman who owns one of these glasses and happens to be a pistol shot also has in his equipment as fine a spotting telescope for either rifle or pistol work as could be desired.

A less expensive telescope by the same firm, which is amply satisfactory for any and all requirements of the pistol range is the Bausch & Lomb draw tube N.R.A. Junior Model.

Special Grips

The pistol shooter is never satisfied with the grip of his gun, and he has a good reason for his lack of satisfaction, for little or no care was given to the design of this most important item until very lately, when Walter Roper induced Harrington & Richardson not only to bring out a single shot pistol and a .22 Revolver with the best grip seen in years, but also to furnish a whole series of five different grips which are quickly interchangeable to fit the ideas and whims of any and every different type of shooter.

The universal search for a better grip is seen in the fact that there are at the present time several different gunsmiths and others who advertise and sell special grips for this and that arm, to overcome various and sundry difficulties of holding and shooting.

One of the greatest troubles with the modern revolver grip has been the deep and narrow space behind the trigger guard, into which the second finger is supposed to fit. If this space is partly filled up, the grip is steadier and more comfortable. For many years the shooters have been filling this space with wooden blocks, pieces of rubber, or other material, usually held on by adhesive tape wrapped around the grip and the filler, or "gadget," as it is often called.

Recently there have appeared on the market a number of first class well designed factory made filler pieces, that look well on a gun, as though they belonged on it to begin with, (which some of them do).

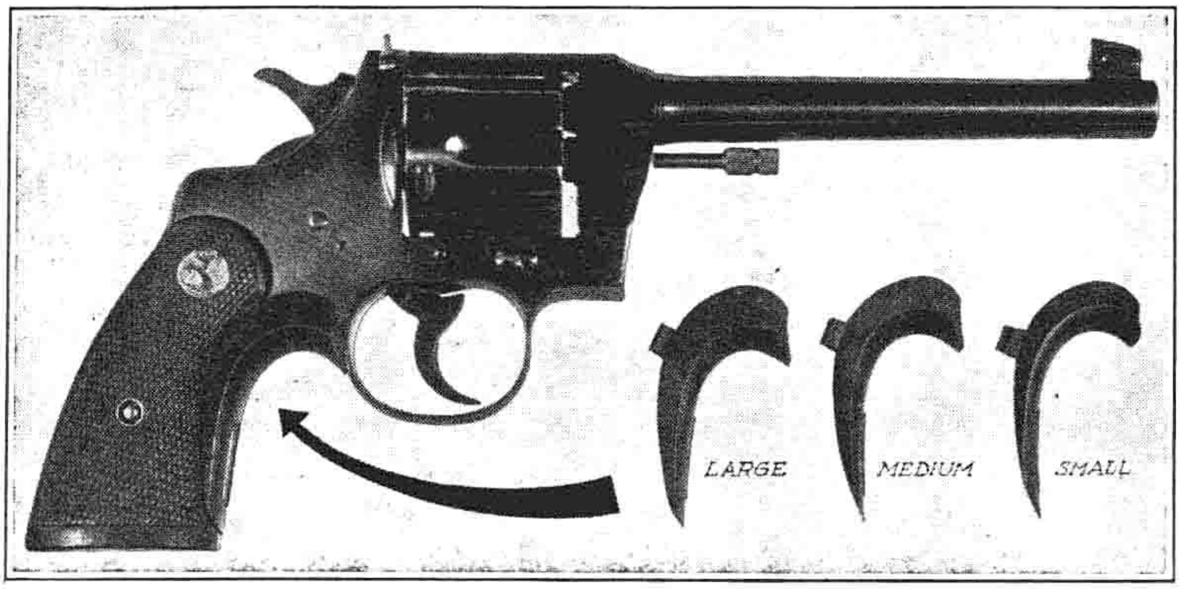
The Harrington & Richardson U.S.R.A. Model Single Shot Pistol and Sportsman Revolver both have the trigger guard constructed with a portion of it extending back in the form of a spur that bridges over the gap behind the trigger guard and forms a metal surface to rest on the middle finger and thus support the gun.

Smith & Wesson make a grip adapter for their .44, .45, and .38/44. It consists of two metal plates which fit between the frame and the walnut grips. The upper part of each of these plates extends beyond the grips and across to the trigger guard, so as to bridge the space behind the trigger guard. Between the two ends of the plates which extend across to the trigger guard there is a rubber filler plate held in place by a screw. This adapter greatly improves the handle of the large caliber Smith & Wesson revolvers.

The Iver Johnson firm has recently brought out a new finger rest in the form of a spur of blued steel fastened to the back strap of the grip frame by a screw. This spur extends forward and bridges the gap between the frame and the trigger guard.

The hole for the screw is slotted so that the spur may be moved up or down about a quarter of an inch to accommodate hands of different sizes.

Another filler for this space which is made for any Colt or Smith & Wesson Revolver or single shot target pistol except the Smith & Wesson Straight Line Pistol and the Safety Hammerless Revolver is the Sure Grip Adapter made by Frank Pachmayr of Los Angeles, and sold by most sporting goods dealers. It consists of a moulded soft rubber adapter curved to fit the space behind the trigger guard and in front of the grip, and held in place by two spring clips of metal moulded into the rubber. To attach the adapter, the grip screw is loosened, and the clips are slipped between the wooden grips and the frame of the gun, after which the grip screw is tightened, and the adapter is held firmly in place.



The Pachmayr Adapter. This device, made in three sizes, as shown, is used to fill part of the space behind the trigger guard so that the hand can take a more natural and less cramped position on the handle of the revolver. It is a practical and very convenient accessory.

These adapters are made in a special individual shape for each of many Colt and Smith & Wesson guns on which they can be fitted. It is necessary therefore to specify what gun is to be fitted when ordering one of these adapters. For each gun there are three different sizes or thicknesses of adapter made, large, medium and small. For the average man the medium size will usually be the most desirable; while for very large hands the small size adapter will be the most comfortable, and for very small hands the large adapter is the most suitable.

Notes on Constructing Ranges

In constructing an outdoor pistol range great care must be used in two particulars. The first and most important one is to be sure that the range is located in a safe position, so that there will be no danger of stray bullets doing any damage. With a great many people shooting on a pistol range there is always a possibility that a wild shot may occur. One or two incidents in which a shot from a pistol club's range got away and did some damage would generally suffice to have the club closed up; therefore, it is of paramount importance that this should never happen. The very best way to insure this safety is to have the range where there is some natural obstacle that will stop any stray bullets. The best natural obstacle is, of course, a hill; next to this is an old abandoned quarry.

Another important consideration is light. On a pistol range the targets should be where the light is as steady as possible, and they should never be located so that the sun will shine directly on them if it can be avoided. The best location for a rifle range is in a north and south direction, with the targets at the north end of the range. At the firer's end of the range there should be a shelter constructed so that shooting can be done in rainy weather and also to prevent undue disturbance by wind. There should be a railing or fence extending along in front of the firing line with tables or shelves on which to lay the ammunition and guns.

The range should be carefully laid out and measured so that the fence or railing at the firing line is 50 yards from the point where the targets are hung, and in order to avoid the records ever being questioned an inch or two should be added to this measurement to make sure that there is no possibility of anyone ever claiming that the range is shorter than the standard.

As an example of the unexpected things that may happen in this regard, the following incident that happened in connection with the Dewar Match of 1931 is related. The author was the American witness of the British firing at the famous Ham and Petersham Rifle Range near London. Before firing the match, it is the duty of the witnesses to see that all the match conditions are correct, and to certify to that fact. This involves measuring the range with a steel tape; but as the firing was to be conducted on a regularly laid out range with everything permanently installed, this seemed entirely superfluous, the same as it would to measure the thousand yard range at Camp Perry with a tape measure before each match. But Lieut. General Sir Alfred Codrington, the British witness, with characteristic British thoroughness produced a steel tape and proceeded to measure the range for my verification, and to our utter astonishment, the range seemed to be short! We could not believe that we could be right, so that we repeated the measurement twice, and then got a different tape and tried again, but with the same result. The range was nearly two feet short. The explanation was that some new style target frames had just been installed, and they projected two feet further toward the firing point than the old ones.

At the target end it is highly desirable to have some stop for the bullets behind each target. Generally old boiler plates are available, and if these are placed behind the target, sloping downward and away from the target, all bullets will be deflected down toward the ground. This is better than putting them upright behind the targets, because heavy lead bullets striking the targets have a tendency to splatter and the pieces will cut the targets. Another very good form of backstop is a mass of wood built up behind the targets out of old railroad ties or similar beams, end-on to the line of fire. In any event, the backstop should extend far enough around the target so that there is no danger of a bullet striking on the edge of the backstop, as this might cause it to be deflected from the line of fire and go in some direction where it might do damage.

The most convenient thing at the target end is to have a deep target pit with target frames that can be lowered into the pit and new targets put on and raised again for firing, but this is generally too complicated for a local club, and usually the best that can be done is to construct a good safe backstop and put up clamps or other means of holding the targets in place. Then the shooters can walk down to the end of the 50-yard target range and examine the targets and put up new ones, or, in case of matches, this can be done by others to avoid the shooter performing this extra exertion between match strings.

Very much the same applies to an indoor pistol gallery; but the problem here is much easier because the range is shorter. A pistol gallery requires 20 yards between the firing point and the target.

Generally there is a partition put up at the firing point which should be an inch or so more than 20 yards from the target holders. This partition has holes or shooting windows put in it, and the contestants stand as near the partition as they desire and shoot through the windows or openings at the targets, which are hung at the distant end of the gallery. There should be a shelf on which to lay the pistol and ammunition, and it is highly desirable to have brackets on which the telescope can be laid for observing the targets between shots.

Most pistol galleries are arranged with traveling target carriers consisting of a cord going over a pair of wheels, one at the firing point and one at the distant end of the range. This cord carries a metal clamp for holding the target, and by turning the wheel at the firing point this clamp travels toward the shooter. When it is at the near end of the range, the old target is taken down and the new target hung in the clamp; then by turning the wheel the target is caused to travel down the range until it comes to a stop 20 yards from the firing point, and when it is against this stop it is also in the circle of illumination because, as stated above, the lighting in an indoor gallery, as in the U. S. R. A. rules, must be done by artificial light.

The far, or target end, of the pistol gallery should be lined with boiler plate sufficiently thick to stop a revolver bullet. It is also highly desirable that the ceiling and the walls of the range be bullet proof. This is very easily accomplished in many places by building the pistol gallery in the basement of a large building. In many of the large modern buildings the walls and ceiling of the basement are likely to be of heavy concrete which would turn a pistol bullet.

It is highly desirable at the firing point to have a boiler plate partition extending backward several feet between each firing point, so that if an accidental discharge should ever occur in loading a pistol, or otherwise, there would be no danger of one of the contestants accidentally injuring the one next to him.

Illumination in pistol galleries is best accomplished by placing a row of electric lights in front of and below the targets. The lights should have reflectors which will throw the light up onto the targets and should be placed behind a long narrow ledge of steel or of concrete which will serve the dual purpose of protecting the lights from stray shots and at the same time hide the lights from the shooter so that the range is in total darkness except for the light reflected from the targets themselves, which, being the only source of light in the range, stand out prominently and thus are most easily seen for aiming. There should, however, be provision for light at the firing points. Firing points are, according to the rules, to be either illuminated or left in darkness at the designation of the shooter. Some people get the best results in target shooting indoors by having no light at all except that which is reflected on the targets. Others like to have enough at the firing point to be able to see their sights. Under any circumstances there must be enough illumination at the firing point for the witnesses to be able to see that the rules are observed and that the shooting is done without any support of any kind.

Improvised Ranges

Besides the regular rifle ranges at organized clubs a great deal of shooting at targets is done by individuals on improvised ranges of their own. At one time when the author was living in Florida he measured off 25 yards from a large pine tree in the back yard, and every day he used to tack a target on this tree and shoot at it with various revolvers and pistols and often .22 rifles. The tree acted as a backstop for the bullets, and if anything missed the backstop there was no danger as there was nothing but a large forest extending for many miles around. After some months of shooting there was a hole in the tree behind the target about four or five inches in diameter and nearly a foot deep, with a mass of lead at the back and at the bottom of the tree quite a pile of lead that had dropped down.

Bullet Stops

A very useful accessory for those who have a cellar or basement with sufficient space for a pistol range is the combined target holder and bullet stop. This is a funnel shaped device of steel, with the mouth of the funnel large enough to extend beyond the edges of the twenty-yard pistol target. At the small end, the funnel curves, so as to deflect bullets entering it, and thus stop them. The K-B backstop is a rectangular funnel of steel that curves downward at the back so as to deflect the bullets down into vertical section. The X-Ring centrifugal bullet trap is a rectangular funnel with the small end curving around in a small spiral. The bullet in going around this spiral loses all of its velocity, and drops into a tin can which is fastened over a hole in the center. This makes it easy to remove the lead for re-melting.

There is a clip for holding a target, and also a bracket with a socket for an electric lamp to illuminate the target. The lamp and target clip are both protected by steel plates to deflect any wild shots. These bullet stops are made in several different sizes, to suit the various ranges and calibers with which they may be used.

Trigger Weights

Every club or range must be equipped with trigger weights, for the rules allow only a certain minimum trigger pull, and require that it be tested before each match. The minimum for single shot pistols under the U. S. Revolver Association Rules is 2 pounds; for "Any Revolver" it is 2½ pounds; and for military and pocket revolvers it is 3½ pounds. The trigger weights should be arranged to test these pulls, and it is well to have several additional pound and half pound weights that may be added to test heavier pulls.

The trigger weight is a lead weight with a steel rod attached to it, with a hook on the end of the rod. The rules require that in weighing the pull, the barrel of the weapon will be held vertical. The common method of measuring the pull is to rest the weight on the bench, and, with the pistol cocked and the barrel of it held in the hand in a vertical position, to hook the trigger under the hook on the weight, and then lift gently upward. If the weight can be lifted from the bench without causing the hammer to fall, the trigger weighs within the rules.

Ordinarily the steel lifting rod and hook are attached to a piece of lead of such a size that both the lead and the rod and hook attached to it weigh exactly 2 pounds. This is the basic trigger weight which is used for single shot pistols. An additional lead weight of ½ pound can be slipped on the rod for "Any Revolver," and still another of one pound for the "Military Revolver."

Sub-Caliber Adapters For Pistols and Revolvers

The greatest drawback to obtaining a sufficient amount of practice with the larger caliber pistols or revolvers is the cost of the ammunition. In order to be able to shoot the guns a reasonable amount without spending too much money, the marksman formerly had to depend on some kind of an auxiliary chamber or barrel liner of smaller caliber, which would enable the inexpensive .22 caliber ammunition to be used. The importance of such devices has declined somewhat in recent years, for many of the more popular large caliber guns have exact counterparts in .22 arms of the same size and pattern, such as for example, the Colt Officer's Model, the Smith & Wesson Model K-.22, the Colt Ace, and others. However, for the man who does not care to spend as much money as these arms cost, there are a number of adapters to be had, and some of them will be briefly described below.

The Webley "Aiming Tube," supplied for the .455 revolver is a .22 caliber barrel having its own extractor in an enlarged breech section. It fits into the barrel of the hinged-frame or tip-up action revolver after the cylinder is removed to make room for the attachment. As the hammer nose of the revolver is intended for center fire cartridges, it strikes directly in line with the center of the bore when the hammer is snapped. This introduces a difficulty, for the .22 cartridge used in the adapter must be struck on the edge; to accomplish this, it is necessary for the barrel of the adapter to be bored off-center, so that the edge of the .22 caliber cartridge will come in line with the striker on the hammer.

Another trouble in designing such an attachment is a tendency to shoot low, owing to the light recoil and the consequent absence of "jump" in the weapon at the instant of recoil. As the regular sights point the revolver low to compensate for the jump, the sub-caliber tube will shoot too low unless it has its own sights. The Webley adapter therefore has its own rear sight, which sits above that of the gun.

The Webley Aiming Tube converts the revolver into a single shot .22 caliber pistol. However, there is another attachment, made by A. G. Parker, Ltd., which has a barrel which goes inside of the barrel of the gun, and also has its own .22 caliber cylinder which goes onto the cylinder spindle in place of the .455 cylinder. This attachment converts the .455 into a six-shot .22 caliber revolver.

The importance of both these attachments is somewhat reduced by the fact that Messrs. Webley & Scott now supply a .22 caliber target revolver of the same size and general pattern of the Mark VI .455 Service revolver, and of the same weight when loaded, which of course forms the very best practice arm for the .455.

For automatic pistols of large caliber, it is quite easy to design a sub-caliber adapter, and several are on the market. Before the advent of the Colt Ace, the author made quite extensive use of a sub-caliber barrel for the .45 Automatic made by R. F. Sedgeley, of Philadelphia. This shot the .22 long rifle cartridge, and like the Webley adapter, it had to be bored off-center to bring the firing pin onto the edge of the cartridge rim. But no auxiliary sight is necessary, as the barrel is bored to compensate for the lack of recoil and jump. This device converts the .45 automatic into a single shot .22. It is designed so that the regular extractor of the .45 pulls out the empty .22 case as the slide is drawn back, but this feature does not always work, so that it is best to be armed with a ram-rod. Moreover, it is somewhat difficult to insert the .22 cartridge into the chamber of the device; but altogether it is very satisfactory, considering the low price.

Just before the advent of the Ace Pistol, A. F. Stoeger of New

York introduced an attachment to convert the .45 automatic into a convenient and accurate single shot .22 pistol. The device, called the "Stoeger .22 caliber attachment for the .45 Government Model or Super. 38" is made to replace the barrel and slide of the regular gun, which are removed to allow the attachment to be pinned onto the frame in their place. The device has a tip-up barrel, with an extractor that pushes out the empty .22 caliber case as the barrel is tipped up to load. It has its own sights as a matter of course, for the regular sights are removed with the slide preparatory to putting the device in place. It is convenient and pleasant to use, but allows single shots only, and quite naturally, the advent of the Ace pistol just after this device was marketed was a severe handicap to its popularity, as many prospective users of such a device would prefer to pay the extra amount and obtain the Ace pistol with which rapid fire practice can be had, and this is especially true as rapid fire is one of the most important features of any match with the automatic.

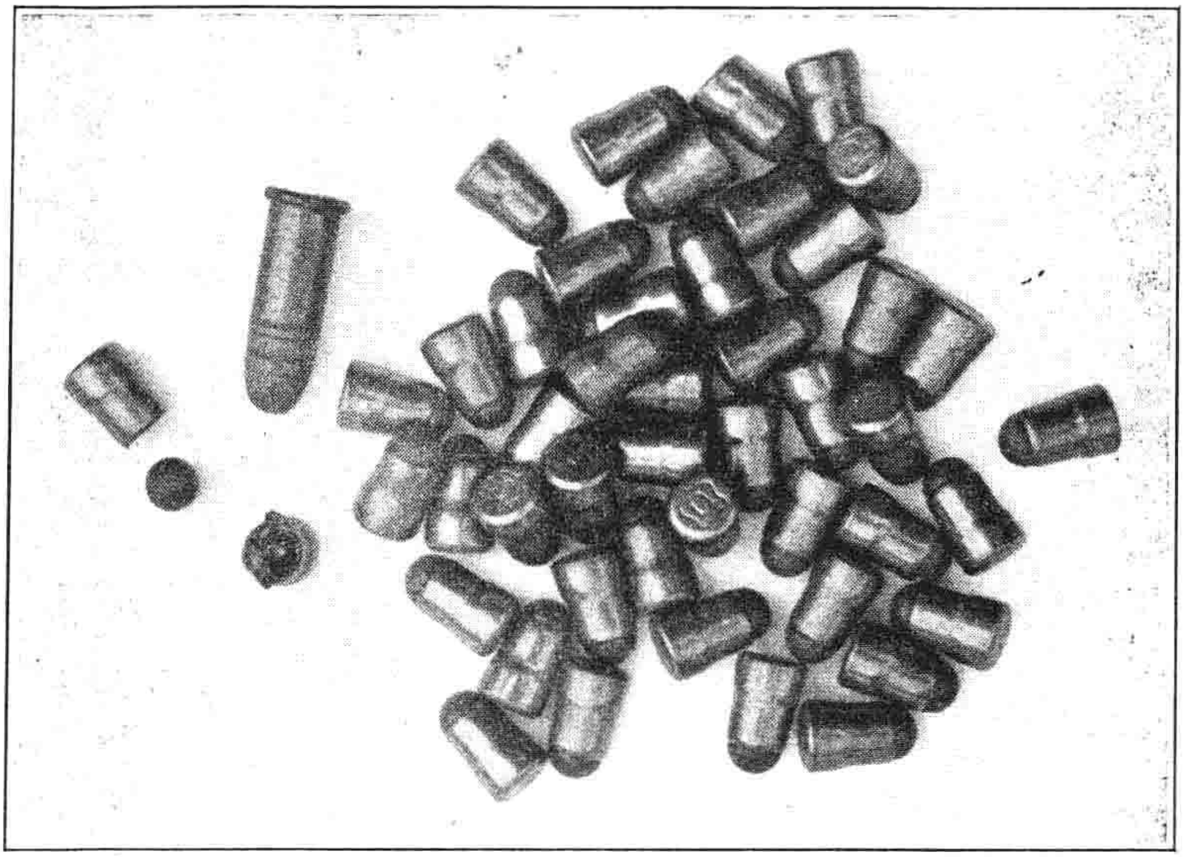
At the present time there is on the market at a reasonable price a .22 caliber "Insert Assembly and Accessories" for converting the Luger Automatic Pistol into a .22 caliber automatic. This consists of a separate barrel, breech block, and magazine. The .22 caliber barrel is inserted into the regular barrel, and the special .22 breech block and magazine replace the regular breech block and magazine. The new breech block carries its own sight. The attachment is supplied for either the .30 caliber or the 9 mm. Lugers.

While it is easy to produce a sub-caliber attachment for the automatic pistol or the tip-up barrel revolver, it is quite another matter to supply a satisfactory device of this kind for the solid-frame revolvers, such as the modern Colt and Smith & Wesson Arms. However, Mr. Albert Noel, of Barcelona, Spain, recently gave the author an opportunity to do some extensive shooting and experimenting with an adapter for the Colt Police Positive Special .38, and another of similar design for the .45 Colt New Service. These adapters are made for the tiny 4 mm. center fire cartridge, which is nothing more than a center-fire primer with a No. 1 shot (.16 inch diameter) attached. There is no powder charge.

These little cartridges look very much like a shotgun primer, being .373 long overall, by .187 in diameter, with the front part necked down to take the .16 diameter ball. There is no rim, and the fact that the rear part is larger stops the little cartridge from going all the way into the chamber. When it comes to extracting, the difficulty is that there is no rim, but a single shot pistol in this caliber has an extractor, which is simply the bottom part of the chamber that is pushed back by the extractor rod, and as the front part of the movable segment of the chamber fits the reduced diameter, pushing back the rod forces out the case. In Mr. Noel's adapters there is no extractor, and the empty is forced out with a rod.

The weight of this little cartridge was determined by trial as 15 grains complete, the ball weighing 7 grains.

These little cartridges are quite popular abroad, as they cost only a small fraction of the cost of the .22, and they are practically noiseless, so that they are well adapted for indoor practice. The report will not disturb a person in an adjoining room. However, in spite of the lack of noise, they have quite a respectable velocity, and will pierce a half inch of wood. They will easily pierce a tin can, break a bottle, kill a small rodent, etc. Mr. Noel's adapters are rifled with 14 fine lands and 14 grooves of the same width, with a twist of one turn in 11 inches. The maker of a single shot pistol of this caliber stated that the best barrel length is 25 centi-

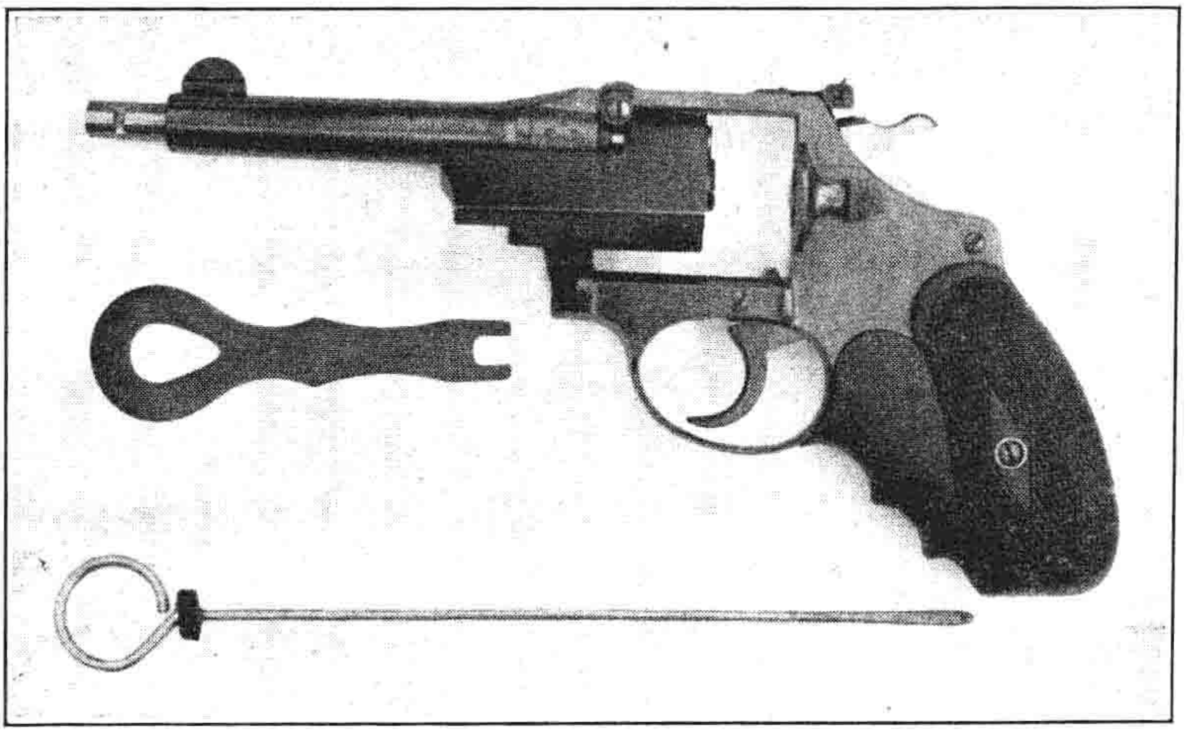


4 mm. center fire cartridges with a .22 short shown for comparison of size. Note that one 4 mm. ball has been pried out of its case and is shown together with its empty case at the left. These little cartridges have no powder, the primer furnishing all the power. They are nearly noiseless, but have speed enough to drive the shot through one-half inch of wood.

meters (10 inches) as power is lost when the barrel is over this length. These 4 mm. cartridges are not made in America, but they may be obtained here, though the price is considerably higher than that of the .22, which is contrary to the situation abroad.

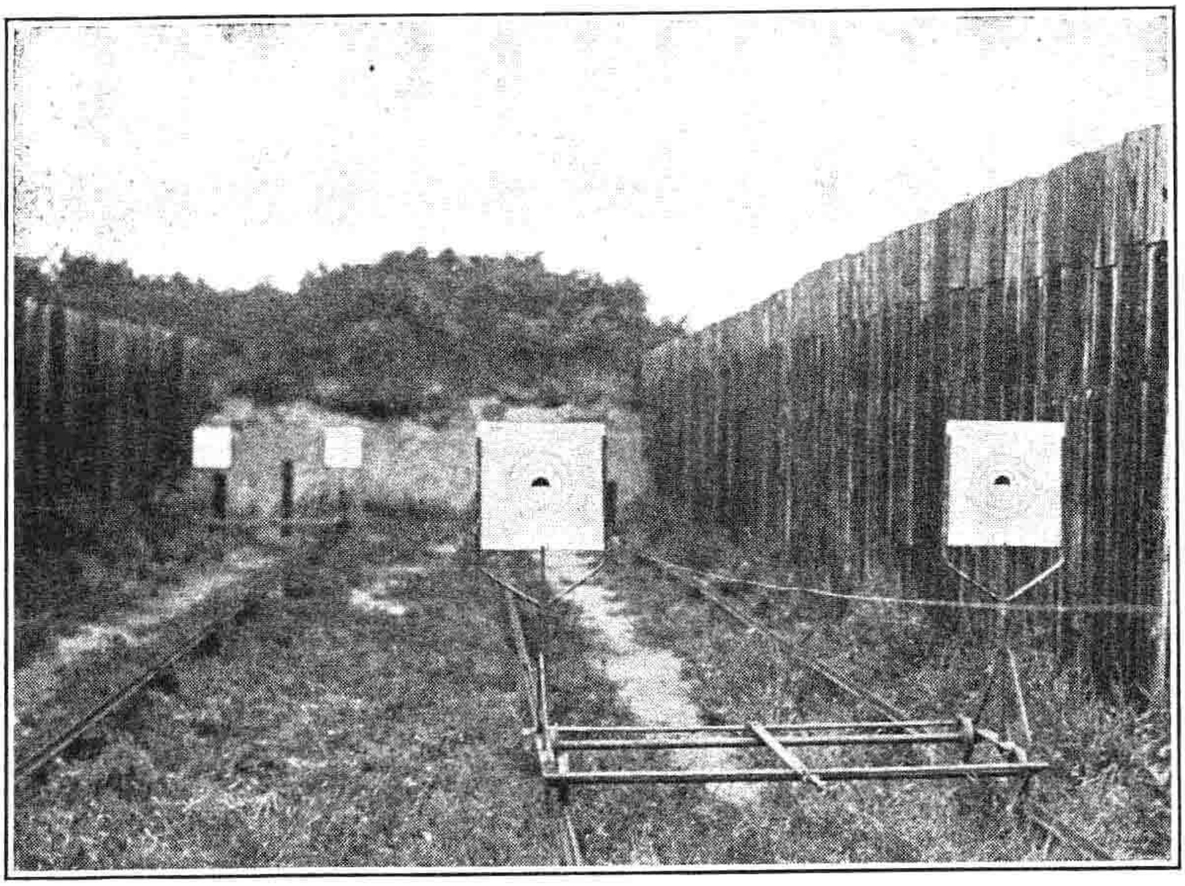
These cartridges have a great advantage for use in the sub-caliber arms, and that is that they are center-fire, and therefore do not require the bore to be off-set, as do the rim-fire cartridges.

Mr. Noel's adapter for the Colt Revolver has a barrel which fits inside the regular barrel, and at its rear end, this barrel is threaded into a breech block which fits into the place ordinarily occupied by the cylinder. This block will swing to the left using the barrel as an axis; though when firing it is locked against swinging by the regular cylinder latch.

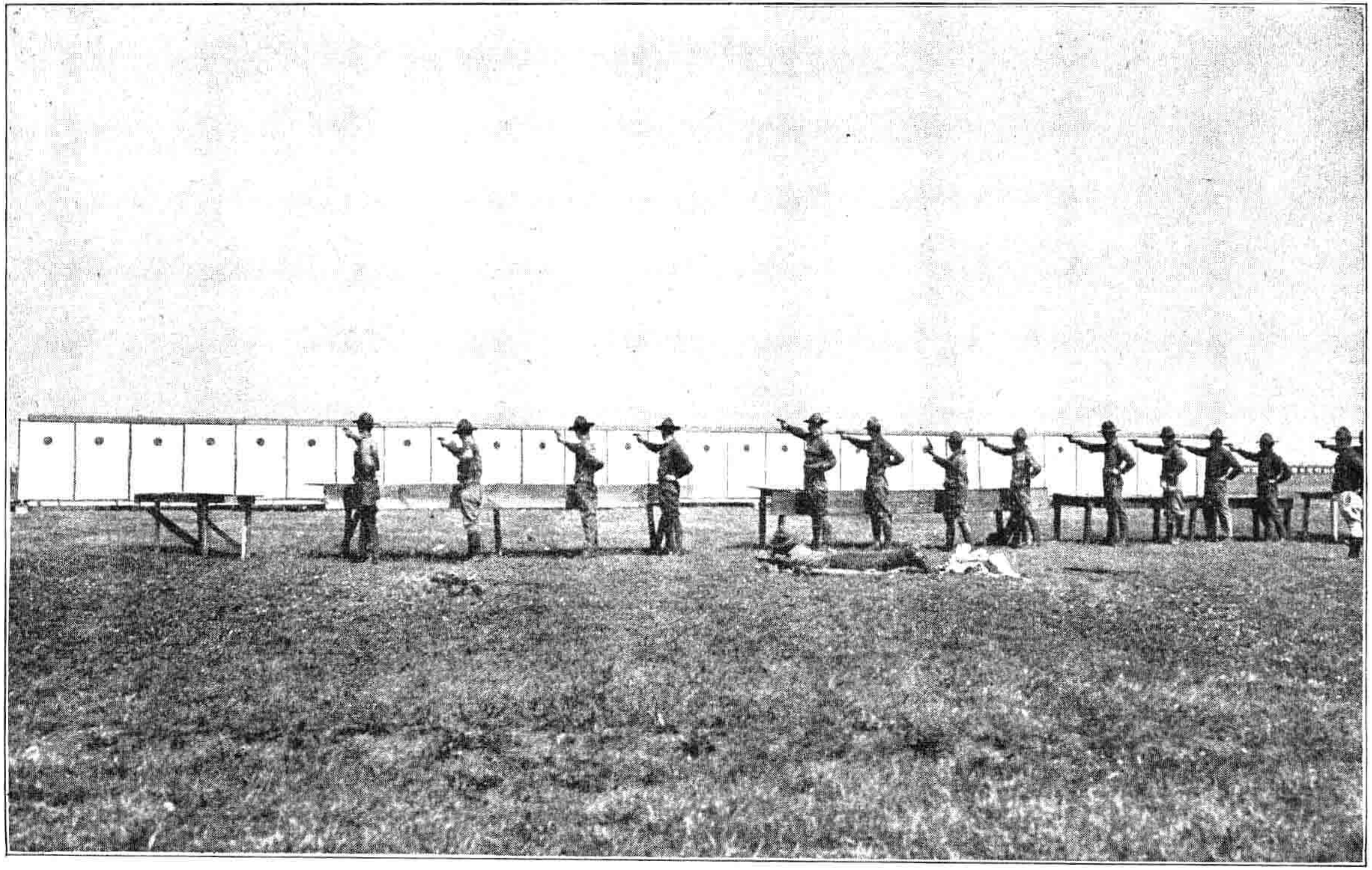


Noel 4 mm Adapter assembled to Colt Police Positive Revolver. The wrench shown is used for unscrewing the barrel, being fitted into the two slots near the muzzle end of the adapter barrel. The rod shown is used for ejecting the fired cartridges. Adapter is shown in the loading position.

To use the adapter in a Colt Revolver, the crane-lock screw in the right side of the revolver frame is partly turned out, the cylinder is swung open, and the crane is then pulled forward and out, carrying the cylinder with it. The sub-caliber barrel is now inserted into the barrel of the revolver, threaded end to the rear, and the breech block is held in the cylinder opening while the threaded end of the barrel is screwed into it until at the last thread, two index marks come into line. Then by pushing the breech-block to the rear and swinging it in, it is locked in the firing position by means of the cylinder latch. After firing, the cylinder latch is drawn to the rear, and the breech block is pushed so as to swing the bottom part of it to the left, the barrel, which is threaded into the top part forming an axis for this motion. When the block has been swung to the left so that its bottom part clears the frame, it can be pushed forward so as to leave space at the rear end of the barrel for the ejection of the empty case and the insertion of a new cartridge. I found this device to be extremely accurate at 25 feet, but of only moderate accuracy at 20 yards.



Portion of the Military Pistol Range at Bisley showing the target arrangement and the wooden stockade walls between sets of targets to prevent cross shooting. The aiming mark, a black hemisphere, represents a steel helmet appearing over the enemy's trench.



An improvised pistol range at Camp Perry. It was established to furnish contestants with a place to practice while the regular range was in use for matches. Strict firing line discipline is necessary with an arrangement of this nature, as the shooters walk up to the targets and do their own pasting at the conclusion of each score.

PART 2

AMMUNITION

CHAPTER 7

GENERAL INFORMATION ON AMMUNITION

THE object of this chapter is to give the reader a few elementary remarks about what ammunition is and how it is made. A more detailed and technical discussion of ammunition will be given in the chapters which follow.

Pistol ammunition consists of gunpowder, bullets, and primers or percussion caps for igniting the powder by means of the blow of a firing pin.

Previous to about seventy years ago, ammunition consisted of loose bullets and gunpowder, and percussion caps. To load a gun, the proper charge of powder was first measured out and put in the gun, after which a bullet was rammed down the barrel of the gun on top of the powder. The hammer of the gun was then cocked and a cap was placed on the nipple. Then if the gun was not to be fired at once, the hammer was lowered to half-cock, where it was securely held just clear of the cap. To fire, the hammer was cocked, the gun was aimed, and the trigger was pulled, allowing the hammer to fall on the cap, which exploded from the impact. The flash of fire from the cap passed through the nipple to the main powder charge, igniting it. The powder then exploded, driving the bullet from the barrel.

In modern ammunition, the powder, bullet, and percussion cap, or primer, are all contained in a brass holder called the cartridge case. The bullet projects from the front end of the cartridge case, and the primer is fastened in the rear end. This combination of bullet, powder, and primer in a brass case is called a cartridge. To fire a gun, the breech end of the barrel is opened, the cartridge is inserted with the bullet pointing forward, and the gun is closed, so that the cartridge is inside. Then the trigger is pulled, and a firing pin strikes the primer, which explodes from the impact. The flame from the primer is communicated to the gunpowder inside the cartridge case, which explodes and drives the bullet out through the gun barrel, leaving the cartridge case held firmly in place in the breech of the barrel. The gun is then opened and the empty cartridge case removed.

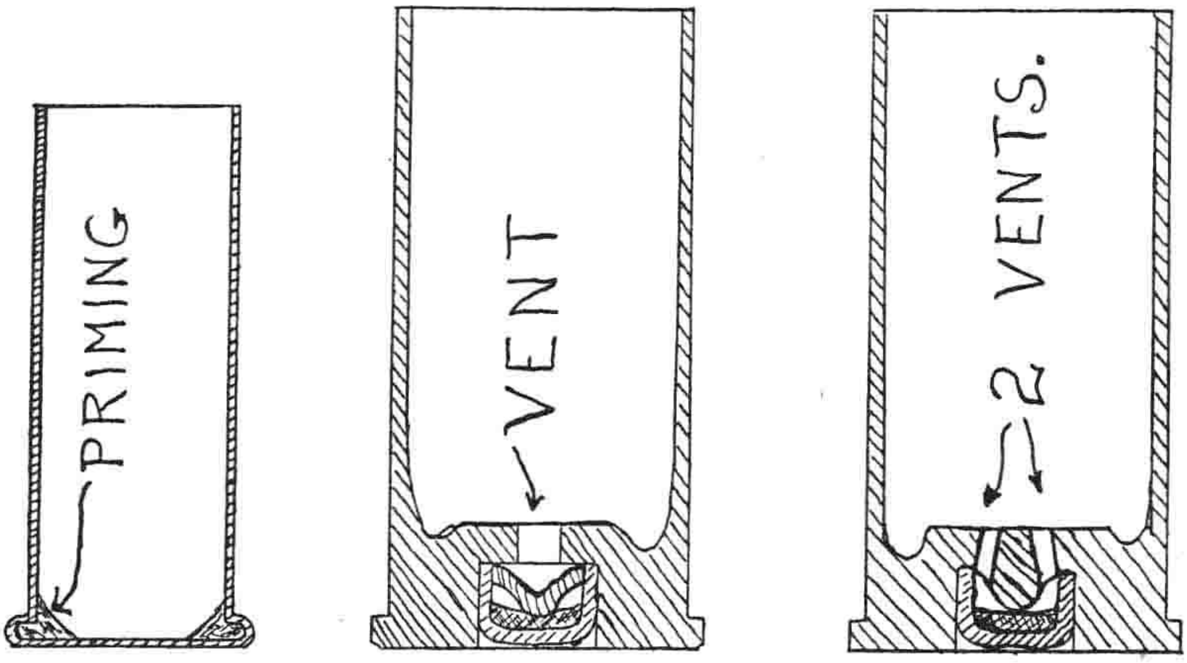
Naturally there are many different kinds of cartridges made for the various weapons in use, and these cartridges vary widely in size. In order to distinguish between the different sizes, they are named by the diameter of the bullet in hundredths of an inch or in millimeters. This is called the *Caliber* of the cartridge. Thus a .45 caliber cartridge has a bullet .45 hundredths of an inch in diameter, and an 8 m/m cartridge has a bullet 8 millimeters in diameter. But this system of naming is not sufficient, as there are many different kinds of cartridge of the same caliber; so additional descriptive matter is added to the cartridge name, as for example, the .45-70 cartridge. This means a .45 caliber cartridge with 70 grains of black powder. It is a rifle cartridge used in the old single shot Springfield Rifle. But there were .45-70 cartridges with bullets of different weights, as for example, the .45-70-405 with a bullet weighing 405 grains and the .45-70-500 with a bullet weighing 500 grains. Thus the first figure following the caliber of the cartridge described in this way is the weight of black powder in grains in the standard load, and the second figure is the weight of the bullet in grains. The figure describing the powder charge is for black powder only, as the smokeless powder charges vary widely depending on the kind of powder used. This system of nomenclature is no longer used for new cartridges, though several older pistol cartridges are described in this way, such as the .44-40, the .38-40, the .32-20, and the .22 Winchester Rim Fire, sometimes called the .22-7-45. Note, however, that the powder figure no longer tells how much powder is actually used in a modern cartridge of this type, loaded with smokeless powder. For example, the .44-40 cartridge, formerly loaded with 40 grains of black powder, now has perhaps only 4½ grains of Bull's-eye powder in it; or a similar charge of some other smokeless powder.

Most pistol cartridges are described by some such name as .45 Colt, .45 A.C.P. (Automatic Colt Pistol), .45 Auto-Rim, etc., or .38 S. & W., .38 Colt New Police, .38 S. & W. Special, .38 Long Colt, etc. In all cases, however, the caliber is given.

Calibers in ordinary use in this country for pistols and revolvers vary from the .22 short, with a bullet weighing 30 grains, to the .45 Colt, with a 255 grain bullet.

Rim-Fire and Center Fire Cartridges

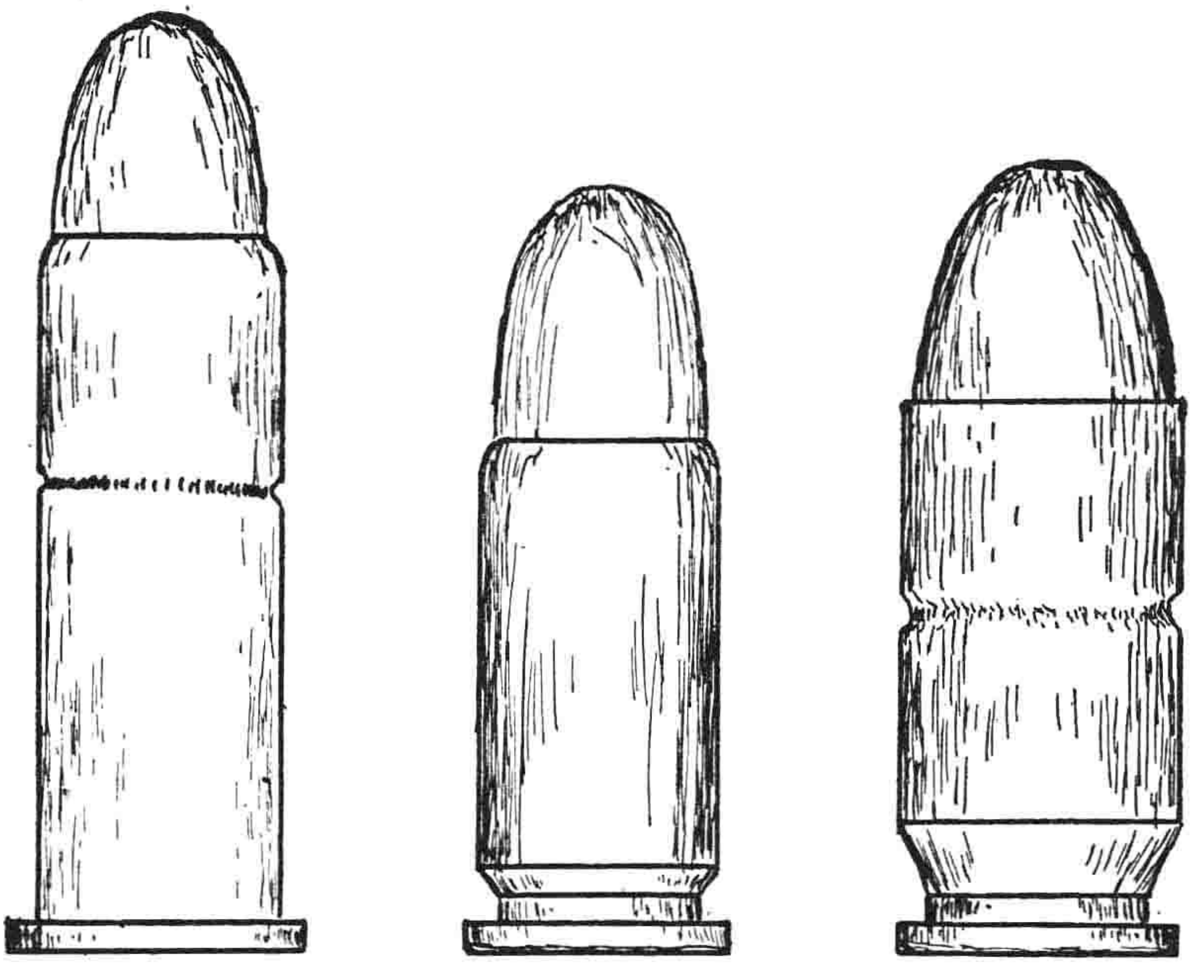
In regard to the primers used, there are two principal varieties of cartridge made in America today, called rim-fire and center fire. The rim fire cartridge is made of thin copper, with a hollow rim around the head. This rim is filled with a percussion composition, and to fire the cartridge, the hammer or firing pin strikes the rim and dents it, thus mashing a portion of the ring of priming and causing it to ignite. The center fire cartridge is made of brass, and has a solid rim. In the center of the head of the cartridge is a circular depression, with a hole in the middle, which communicates with the inside of the cartridge. Into this depression a cap or primer is forced, with a tight sliding fit. When the cartridge is to be fired, the cap is struck by the firing pin, denting in the top of it and smashing the percussion composition which it contains against a pointed piece of brass inside called the anvil. The fire which results from the ignition of the primer flashes through the hole in the bottom of the primer cup and ignites the powder inside the cartridge.



Types of primer used in pistol cartridges. Left, rim fire. Middle, center fire with separate anvil. All American center fire cartridges are made like this. Right, center fire with anvil integral with the case; called the Berdan primer. Used in all European center fire cartridges.

Rim, Rimless, and Semi-Rim Types

As mentioned above, the center fire cartridge has a solid rim. Right here it might be well to state that most cartridges have a rim around the head of the case to stop the cartridge from going all the way into the gun, and to support it against the firing pin blow, as well as to give something for the extractor to hook onto when drawing the cartridge out after it is fired. However, the rim interferes with the feeding of the cartridges from the magazine of an automatic pistol, hence most automatic pistol cartridges are made in what is called the rimless type. The head of the cartridge is the same diameter as the body, and has a groove cut around it for the extractor to hook into. As there is no raised head or rim to stop the cartridge from going all the way into the barrel, the chamber is made slightly larger in diameter than the barrel and there is a shoulder at the front end of the chamber against which the front edge of the cartridge rests to support it against the firing pin blow.



Three common types of center fire pistol cartridges. Left, the rim type. (.38 S. & W. Special). Middle, Semi-rim cartridge for automatic pistols. The rim projects only far enough beyond the body diameter to stop the cartridge from going all the way into the chamber, and to form a support for the cartridge against the firing pin blow. (Super .38 Automatic). Right, the rimless type. The front of the case is left square and abuts against a square shoulder at the front of the chamber. (.45 Automatic).

There is still another type, used in some automatic pistols, such as the Super .38 Automatic, which looks like the rimless type at first glance, but is not strictly rimless, for the rim actually does project very slightly above the line of the body; and these cartridges use this projection of the rim to keep from going all the way into the gun, instead of having the front edge of the cartridge case strike against a shoulder in the barrel as do the rimless cases.

Black and Smokeless Powders

There are three principal kinds of powder used for loading the modern pistol cartridge. These are black powder, which was used exclusively up until about forty years ago; smokeless or nitro powder; and semi-smokeless powder, which is a mixture of the other two kinds. Black powder has a heavy recoil, gives off a large quantity of white smoke when fired, and fouls the gun barrel very badly. Smokeless powder gives off little or no smoke, does not foul the barrel appreciably, makes less report, and kicks less than black powder. On the other hand it must be loaded with great care, as it is more sensitive to overloads and other conditions, and from this viewpoint is not as safe as is black powder. The principal semi-smokeless found in commercially loaded pistol cartridges is Lesmok, with which many .22 caliber cartridges are loaded. It is extremely uniform in its action, and is a favorite for target shooting. More detail in regard to powders is given in another chapter.

Bullets

The bullet weights range from 30 grains for the .22 Short to 255 grains for the .45 Colt. Bullets are made usually of an alloy of lead and tin. The tin is used to harden the lead, so that it will not collect on the inside of the barrel—that is, "lead the barrel," as it is called. In general, a very soft lead bullet is more effective for stopping power than one that is hardened, but most pistol bullets are made of about one part of tin to fifteen parts of lead. Some pistol bullets are made with a jacket of harder metal covering the lead. These are called "jacketed" bullets, or "full-metal-patch" bullets.

For revolvers plain lead bullets are usually preferred, but for automatic pistols jacketed bullets are generally used to avoid battering in the magazine and to avoid jamming the cartridge in feeding. The full-metal-jacketed bullet does not have as good stopping power as the lead bullet. It has more of a tendency to glance when striking hard objects. A jacketed bullet has more accuracy in any pistol or revolver than a pure lead bullet in the same gun; but this slight increase in accuracy does not outweigh some other disadvantages of the jacketed bullet, which are its lack of stopping power and its tendency to glance or to be deflected easily from its path. A wound made with a jacketed bullet generally heals up more quickly than one made with a lead bullet.

Many rifle cartridges are made with a metal jacket, but with a soft lead point exposed. These are called "soft-point" or "mushroom" bullets, because they expand on striking an object, and therefore produce a much more serious shock and have correspondingly greater stopping power. This is true when they are used in rifles, but is not true when used in revolvers, because no revolver has enough velocity to cause a mushroom bullet to expand. Very soft lead bullets used in revolvers will expand somewhat on striking a bone, however.

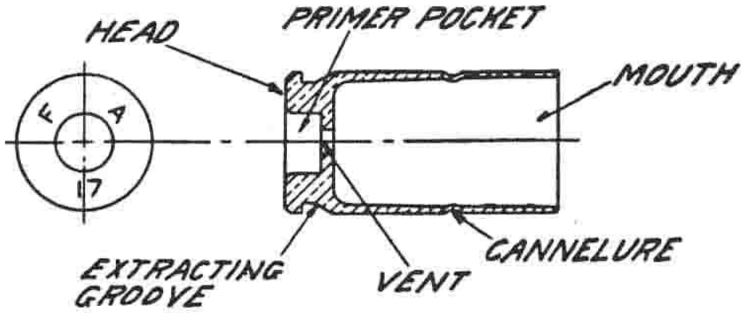
The jacket of a metal-patch bullet is generally made either of cupro nickel or gilding metal. Cupro nickel is a combination of 60 per cent copper and 40 per cent nickel and is a white material like German silver. Gilding metal is a combination of copper and zinc. Years ago the Government pistol bullets were jacketed with gilding metal of 95 per cent copper and 5 per cent zinc. Now the mixture used is 90 per cent copper and 10 per cent zinc. Up until a few years ago the Government pistol bullets have been tinned lightly after manufacture in order to make them have a white appearance and avoid possible corrosion of the copper jacket. These jacketed bullets are the ones that are meant by newspaper reporters when they refer to "steel-jacketed" bullets. This term is not strictly correct, as steel is not used as a bullet-jacketed material in America at the present time, nor has it ever been except experimentally.

A good many foreign cartridges have steel jackets, however. Some of these foreign steel-jacketed bullets are covered with a thin coating of copper on top of the steel to prevent corrosion. This material is called "copper-clad steel." It is made by welding a sheet of copper onto a sheet of steel and then rolling it out thin. The copper spreads out as the steel is rolled, and no matter how thin it is, it always has a coating of copper on the outside. Cupro-nickel-covered steel is also used. Collectors and others who want to know what material bullet jackets are made of generally have, among their accessories, a magnet, as this is useful in detecting steel jackets.

All lead bullets must be lubricated to prevent the lead from sticking to the barrel inside and piling up in lumps. The metal-jacketed bullets, however, are not lubricated. The modern lead pistol bullet has from one to three grooves around it which, in the finished cartridge, are covered up by the neck of the case, and these grooves are full of a lubricant, usually Japan wax. A cartridge made like this is called "inside lubricated." Many of the older pistol cartridges, especially the rim-fire type, have grooves outside of the cartridge case which are filled with grease, and in some cases the whole bullet is dipped in grease so it is covered with a thin layer of lubricant. Such cartridges are called "outside lubricated." A common example is the ordinary .22 Long Rifle cartridge, which, as everyone knows, is covered over with a film of lubricant. A disadvantage of the outside lubrication system is if the cartridges are carried loose the bullets pick up foreign material which becomes embedded in the grease.

How Cartridges are Made

In the manufacture of a pistol cartridge a sheet of brass about ⅛ of an inch thick is fed into a punch press, which first cuts out a little disk of brass and then forms it into a cup shape. These little cups are fed through successive presses, in each of which the cup is forced through a die by a steel punch in such a manner as to elongate the brass cup. When the cup is long enough to have the approximate shape of a cartridge case it is placed in another press, which flattens the head of it so as to form a rim around it and puts a cup-shaped depression in the head for the primer to fit into. The case is then nearly completed. It is afterwards trimmed to length, and the rim is turned to exact thickness and diameter on a machine similar to a lathe. A hole is also punched in the bottom of the primer pocket for the flash of the primer to go through. After being washed to free it from all oil and residue the case is ready to have the primer inserted.



CAL. 45 BALL CARTRIDGE CASE MODEL 1911.

It is interesting to note that the brass, when it first comes to the cartridge factory in strips, is very soft, but the work of forming it up into cups makes it become hard. Before it can be further drawn out it must be heated up to a red heat to soften it again, and this process is called "annealing." A cartridge goes through several of these annealing processes between the various draws it gets in changing from the form of a flat disk to that of a long thin cup. These annealing and drawing operations must be so adjusted that the cartridge has a certain hardness or temper after the last operation; otherwise it will not have enough strength in the head, and under heavy pressures the head would expand and allow the primer to fall out.

Manufacture of Bullets

If pure lead bullets were used they would be so soft that they wound tend to jump the rifling, or "strip," and would lead the barrel badly. By mixing certain hardening materials with the lead, such as antimony or tin, the tendency to lead is reduced and the bullet will hold its shape better.

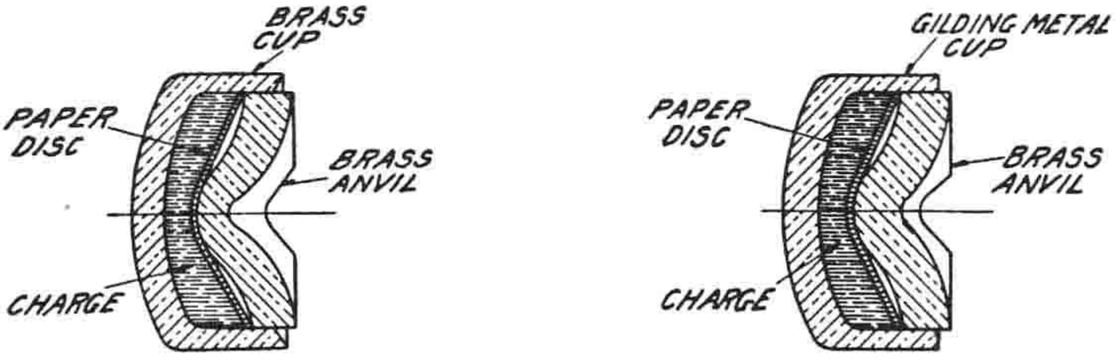
The lead bullet for a pistol cartridge is manufactured by one of two processes. The process used at Frankford Arsenal consists of melting the proper mixture of lead and tin together and pouring it into a large ingot. This is then put into a high-pressure press, which forces the lead out in the form of wire about four-tenths of an inch in diameter. As it comes from the press this wire is wound on reels. This lead wire is afterwards taken to a swedging machine, which is entirely automatic in its action and which first cuts off a short section of the lead wire and then forces it into a hole the exact size of the bullet, under very heavy pressure, so as to form the bullet perfectly to shape except for the lubrication grooves. The bullets as they come from this swedging machine, if they are to be plain lead bullets such as those for the .38-caliber revolver, are then taken to a machine which rolls some grooves around them for the lubricant. They are then fed to a machine which forces lubricant into these grooves under pressure, and the bullet is then complete.

The other factory method of making bullets which is used in many ammunition factories in this country, is to cast the bullet mixture into little slugs, each containing the proper amount of lead for one bullet. This casting is done automatically in revolving moulds which operate very rapidly. The bullet slugs are then taken to a machine where they are swedged to final shape and then finished up as previously described.

When a jacketed bullet is to be made, the first part of the process is just the same. A slug is swedged to proper size and shape for the core of the bullet. The bullet jacket is then drawn up out of cupro nickel or gilding metal in just the same way that a cartridge case is drawn. The lead cores are then inserted inside of the jackets and the partly assembled bullet is placed in a die under a heavy press and a punch turns over the base of the jacket on the lead and presses the whole bullet together so that it is solid.

Primers

There are two sizes of primers commonly used in the center-fire cartridges of American make. The small size, used for the smaller cartridges, is .175 inch in diameter, while the larger one is .211 inch in diameter. Frankford Arsenal uses a special size primer for the .45 Colt, having a diameter of .204 inch. In America the center-fire primer has a separate anvil which is contained in the primer itself, while in the European cartridges the anvil is fitted in the cartridge case and is not a part of the primer. This European style is known, after its inventor, as the "Berdan" type of primer, while the other is called the "Boxer" type. The rim-fire cartridges have their copper shell with a little priming mixture spread around in the rim.



CAL..30 PRIMER. CAL..45 PRIMER

American Type Primers.

Primer Compounds

The key to the primer composition is some material that will explode when it is crushed, as will the head of an ordinary "strike anywhere" match. The material most often used for this purpose in primers, until very recently has been Chlorate of Potash. If this substance is powdered very fine and mixed with almost any inflammable substance of granular texture, such as sulphur, it will explode from very moderate friction or crushing. In fact, I have known small boys to purchase this substance at drug stores, and mix it with powdered sulphur to make a fourth of July explosive that will go off violently when laid on street car tracks, etc.; or the experimentally inclined will mix it with sugar, forming a compound that will explode when a few drops of sulphuric acid is allowed to come in contact with it. However, I want to warn most emphatically against any such maneuvers, as the experimenter is likely to encounter unpleasant surprises. Chlorate of potash is very dangerous to handle. An attempt to powder it will often result in a violent explosion, which can easily have a fatal result, even when only a very small quantity is being handled.

In addition to the chlorate, some fuel is added; and the effectiveness and sensitivity is increased if the fuel is gritty in nature, so that the friction on the chlorate is increased. Antimony sulphide, or stibnite, as it is called in the native state, is the best known of such substances.

The primer used at the present time in the .45 caliber pistol cartridge as made at Frankford Arsenal has the following composition:

Potassium Chlorate	53 per cent
Antimony Sulphide	17 " "
Lead sulpho-cyanide	25 " "
Tri-nitro-toluol (T.N.T.)	5 " "

This mixture is moistened with gum water, which is a kind of thin mucilage, and then it is pressed into the primer cups and covered with a layer of shellacked paper. The anvils are then forced into the cups while the mixture is still wet, and the assembled primers are put into a drying house, where they are thoroughly dried out, which makes them very sensitive. After being dried, they are pressed into cartridge cases which have not been loaded with powder. After the priming of the cases has been successfully accomplished, they are ready to have the powder and bullet put in.

A typical rim-fire priming composition is the following, used in the United States Cartridge Company's N.R.A. Outdoor Type .22 Long Rifle Cartridge. This was obtained by chemical analysis of samples.

Potassium Chlorate	41.43 per cent
Antimony Sulphide	9.53 " "
Copper Sulphocyanide	4.70 " "
Ground Glass	44.23 " "

The average weight of the pellet of priming in this cartridge, (U.S.N.R.A.) was found to be 0.237 grain.

These compositions are both of the type which will cause corrosion unless the gun is promptly cleaned after shooting. The damage is done by the potassium chlorate, and consequently, a determined effort was made to get rid of this component, with the result that in 1928 the non-corrosive type of priming came into use by all the large American cartridge companies.

The following table gives the composition of the early non-corrosive priming compositions as used by several of the companies:

	Remington Kleanbore	*Remington Palma*	*Western*	*Winchester Staynless*	*Peters Rustless*
Mercuric fulminate	44.40	42.62	40.79	41.06	38.68
Barium Nitrate	30.54	27.40	22.23	26.03	9.95
Lead sulphocyanide	4.20	7.17	8.22	5.18	....
Ground Glass	20.66	22.13	28.43	26.66	24.90
Lead compound*	....	....	....	....	25.91
Gum, etc.	.20	.68	.33	.58	.56
	100 pct.	100 pct.	100 pct.	100 pct.	100 pct.

*Exact composition undetermined.

These primers were indeed non-corrosive, but they suffered from a tendency to become insenitive, and give hang-fires and misfires, through deterioration of the mercury fulminate which formed a large percentage of each mixture. Cartridges loaded with these mixtures, when kept on the shelf for a year or two, especially in warm and damp climates, became worthless.

In order to overcome this serious defect, it was found necessary to find a substitute for the mercury fulminate. This was finally accomplished, and the mixtures given above became obsolete. All the companies now make a non-mercuric non-corrosive primer composition.

Examples of a non-mercuric non-corrosive primer composition are given in U. S. Patent No. 1889116, by Edmund Ritter Von Herz and Hans Rathburg, assignors to Remington Arms Company, as follows:

COMPOSITION No. 1

Ingredient	*Percentage*		
Guanyl Nitro-amino-guanyl-tetracene	0.5	to	15.
Lead tri-nitro-resorcinate	20.	"	45.
Barium Nitrate	30.	"	50.
Antimony Sulphide and/or other fuel, as, e. g., Calcium Silicide	10.	"	30.

COMPOSITION No. 2

Ingredient	*Percentage*		
Guanyl Nitro-amino-guanyl-tetracene	0.5	to	2.0
Lead tri-nitro-resorcinate	35.	"	40.
Barium Nitrate	35.	"	42.
Lead peroxide	7.0	"	12.
Antimony Sulphide	0.	"	5.
Calcium Silicide	0.	"	12.
Glass	0.	"	3.

Priming and Loading the Cartridges

With the cartridge case, the primer, the bullets and the powder all at hand the next step is to prime the cartridge cases. They are sent to an automatic machine that inserts a primer into the primer pocket of each case, presses it home and places a little ring of waterproof and oilproof lacquer around the joint between the primer and the primer pocket.

The cartridges are now sent to the loading machine, which has three hoppers, one containing empty cases, one containing bullets, and the other having powder in it. The cases are fed down a long tube into a dial holder which carries them under a spout from the powder dome, where each cartridge receives an exact charge of powder. Next they go under another spout where a bullet is deposited on the mouth of the case, and a little further along a plunger seats the bullet to the proper depth in the mouth of the case. In the automatic pistol cartridges the bullet is held in place by friction, but in most of the others the brass is firmly crimped into the lead to hold the bullet securely in place.

Before, during, and after this loading operation, the cartridge cases, bullets, and primers are subjected to careful inspection to be sure that there are no defects, and the loading machine itself is fitted with a number of elaborate and delicate feelers and safety devices to insure that no cartridge will get by without a powder load, with an overload, without a primer, or with the primer upside down, etc.

With the large number of operations on a cartridge, and all the engineering skill, care and accuracy that goes into its construction, it seems remarkable that the finished product can be sold for such a relatively small price.

CHAPTER 8

INTERIOR BALLISTICS

INTERIOR ballistics is the study of what happens from the time the firing pin hits the primer until the bullet leaves the barrel. It deals chiefly with such things as powder pressures, muzzle velocity, recoil, etc.

Interior ballistics is a big subject, and is full of the most complicated and abstruse mathematics. Whole books have been written on this subject alone, so the reader will readily understand that this chapter does not in any sense of the word pretend to be a treatise on Interior Ballistics. It is merely a non-technical talk on some of the simpler phases of the subject, with particular reference to the interests of the pistol shot.

When the firing pin hits the primer, the priming composition ignites, and in turn sets the powder on fire. The powder burns very quickly in any case, but relatively there is a big difference in the speed of burning, depending on how closely it is confined. If you light a charge of smokeless powder in the open air, the unconfined powder will burn up in a few seconds, just like so much celluloid. But if it is slightly confined, the pressure and heat of the gases given off by the first particles to burn will add to the heat and pressure that is applied to the remaining particles, and will make them burn faster. In a revolver, the powder is confined in the very small space in the base of the cartridge behind the bullet; and the only way it can expand is to push the bullet along the barrel. The heavier the bullet, the more effective is the confinement of the gas, and the more quickly will the powder burn. The speed of burning depends also on how much empty space there is in the cartridge case. For example, if the case is only half full of powder, the vacant space in there is available for the gas to expand into at the beginning of the explosion, and the burning of the powder gets underway less rapidly than it would if the case were full of powder and there was no vacant space inside.

Cartridge Case Capacity

The following tabulation gives the powder capacity of various pistol and revolver cartridges in cubic inches. These figures are subject to a slight variation from time to time as manufacturing methods change, and moreover, they are not exactly the same for the different makers, but these typical examples, taken from measurements of cartridges of Winchester make will be found to be of value where it is desired to obtain an idea of the relative capacity of the different cartridges.

This is of importance, because the space for the charge has a lot to do with the way in which the powder burns. If the powder nearly fills the space, the pressure will be much higher than if the space is only partly filled.

Name of Cartridge	*Volume of Powder Space, Cubic Inches*
.25 A. C. P.	.013
.32 S. & W.	.026
.30 Mauser	.061
.30 Luger	.042
.32 S. & W. Long	.044
.32 Colt's New Police	.044
.32 A. C. P.	.019
.32 -20	.065
9 MM Luger	.033
.38 S. & W.	.043
.38 Colt New Police	.043
.38 Long Colt	.063
.38 S. & W. Special	.079
.38 A. C. P. (Super .38)	.049
.38 -40	.128
.41 Long Colt	.066
.44 S. & W. American	.089
.44 S. & W. Russian	.086
.44 S. & W. Special	.112
.44 -40	.129
.45 Colt	.125
.45 A. C. P.	.051

Pressure

When the powder burns, it all turns into gas, and there are many times the volume of gas produced as there were of the original powder. Yet when this gas is first produced, it is all confined inside the cartridge. That makes it have a very high pressure. This pressure exerts itself equally in all directions, on the sides of the cartridge case, on the back of the case, and on the bullet. The walls of the case are prevented from moving by the fact that they fit closely inside the chamber. However, the gas pressing on the base of the bullet and the inside of the cartridge head tends to separate these two surfaces and increase the distance between them.

The pressure in the chamber of the .45 Automatic Pistol is 14,000 pounds per square inch, and as the base of the bullet has an area of .159 square inch, that means that the total pressure in pounds on the base of the bullet is 2,225 pounds, or well over a ton. The pressure on the inside of the base of the cartridge is the same. This means that when the pistol is fired, there is a pressure of a ton pushing the bullet forward, and an equal pressure trying to push the pistol back.

As soon as this pressure is applied, the bullet starts to move forward, and the gun starts to move back. The bullet is much lighter than the gun, and can therefore get under way more quickly; but at the same time that the bullet moves toward the muzzle, the gun is moving back, and the speed of the gun's motion as compared to that of the bullet depends entirely on the relative weight of the gun and the bullet. The pressure works in all directions equally, and it moves the gun back as fast as the inertia of the gun will allow it to move. At the same time it moves the bullet forward as fast as the inertia of the bullet will allow it to move. The bullet has less inertia, so it moves faster.

It is this backward motion of the gun, as described above, that causes the recoil. The lighter the gun, the more easily it can move back, and the greater the recoil. Also, the lighter the bullet, the more quickly it can get out of the barrel and release the pressure, and the more quickly the powder gas will stop pushing the gun, and therefore a light bullet means a light recoil.

If the gun and bullet weighed the same, the gun would come back as fast as the bullet goes forward. It is the superior weight of the gun that protects the user of it from the pressure of over a ton that is pushing it back onto him. Another thing that saves him is the fact that the pressure lasts only a very small fraction of a second, and before the gun has moved very far, the pressure is gone, because the bullet has moved out of the barrel.

Time of Bullet in Barrel

It is really very easy to get a good close approximation to the length of time it takes a bullet to get out of a barrel. For example, take the .45 Automatic, with a five inch barrel. When the bullet leaves the barrel, it has a velocity of 810 feet per second.

It would move 1 foot in 1/810th of a second, and it would move 5 inches, the barrel length, in 5/12ths of 1/810th of a second, which is 1/1944th of a second. If the bullet started to move at this speed as soon as the powder was ignited, and moved at the same speed until it was out of the barrel, this is how much time it would take. But obviously, it does not do this, but takes longer, because it moves slowly at first, and gradually gets up speed, and while moving slowly at the first part of its path, it is losing time.

We might figure that at the beginning it had no speed at all, and when it left the barrel, it had a speed of 810 f. s., so that the average speed in the barrel is the average of 0 and 810, which is 405. Under this assumption, which is not so far from the truth, the bullet would take twice as long, or 1/972 of a second to traverse the barrel. However, this is not exactly correct, and if we want an even closer figure, we can get it by applying a little additional knowledge. The bullet starts from rest when the explosion occurs; and the pressure is highest at this instant, so that the most force is being applied to the bullet in the early part of its travel. As it moves along the barrel, the space for the gas to expand into is increased, so that the gas loses part of its pressure. The bullet continues to gain, but not so fast. The curve of velocity, if plotted out, resembles a parabola, where the average value of all the velocities is 2/3 of the final velocity. Thus the average velocity of the bullet in the barrel under this assumption would be 2/3 of 810, or 540 f. s., and the time required to traverse 5 inches at this speed is 1/1296th of a second, or, expressed in decimals, .00077 second. This is about three quarters of a thousandth of a second. It is merely because the pressure of a ton that you are holding at the end of your arm when you fire the automatic pushes against you for less than a thousandth of a second that it does you no harm. Even so, it causes a rather severe recoil.

Now that we have seen how to figure out how long the bullet takes to go through the barrel, we will go on and discuss the question of velocity. That means that we will have to leave the question of recoil, but later in this chapter we will discuss it and show it can be calculated, and what effect it has on the grouping of the bullets on the target.

Velocity

We have seen that in the .45 caliber automatic pistol there is a maximum powder pressure of about 14,000 pounds per square inch, and as the base of the bullet has an area of a little over one-sixth of a square inch, there is an actual push on the bullet of about 2225 pounds.

Naturally this push on the base of the bullet moves it, and as the bullet is very light, and the push is very large, the bullet moves very rapidly under the influence of this tremendous force.

According to the laws of physics, the velocity that will be caused by any force acting on a movable object for one second is equal to the force in pounds, divided by the mass of the object. The mass is defined as the weight divided by the acceleration of gravity, 32.16, or in round numbers, 32. The weight of the object must be in pounds. If the force acts for two seconds, the velocity will be twice as great. This is expressed by the formula $v = \frac{Ft}{m}$ where v represents the velocity, F the force in pounds, m the mass of the object, and t the time during which the force acts. Also, if a force is allowed to act through a given distance instead of through a given length of time, the velocity that will be imparted to the object will be equal to the square root of two times the force multiplied by the distance through it acts, divided by the mass of the object, or, expressed as a mathematical formula $v = \frac{\sqrt{2FS}}{m}$, or $v^2 = \frac{2FS}{m}$ where S represents the space through which the force is allowed to act, and the other letters represent the same quantities as before.

Thus if we have a force of 2225 pounds pushing on the base of a bullet that weighs 230 grains until the bullet passes out of the 5 inch barrel of the automatic pistol, we can find out from the formula just what the velocity would be. For F in the formula, substitute 2225; for S, substitute the barrel length of 5/12th of a foot; for m substitute the bullet weight *in pounds* divided by the gravitational constant 32. To bring the bullet weight of 230 grains to pounds, divide by the number of grains in a pound, or 7000. Thus m would be 230/7000 x 32, and we would get $v = \sqrt{\frac{2 x 2225 x 7000 x 32 x 5}{230 \times 12}}$ or $v = \sqrt{1,840,000}$ or 1343 feet per second.

But we know that we do not get this much velocity in the pistol. The muzzle velocity is only 810 feet per second. Why the difference?

The answer is simplicity itself. Our powder pressure of 14,000 pounds per square inch does not remain at the same figure as the bullet moves along, for as more space is provided for the gas by the motion of the bullet along the barrel, the gas has more room to expand into, and naturally the pressure drops. When the powder is first ignited, it has only the powder space in the cartridge case to hold all the gas. This space in the cartridge is only four-tenths of an inch long. By the time the bullet has moved a half inch along the bore, the powder has twice the space to expand into; and by the time the bullet has reached the end of the barrel, the gas will have expanded to 12½ times the volume of the powder space in the cartridge. At this point, the pressure will have dropped to a small fraction of the maximum of 14,000 pounds.

We can just as easily reverse our formula to find the average pressure if we know the muzzle velocity. For example, transposing the formula we have $F = \frac{mv}{2S}$. Working this out for the 230 grain bullet with 810 f. s. velocity gives $F = \frac{230 \text{x} 810 \text{x} 810 \text{x} 12}{2 \text{ x } 32 \text{ x } 7000 \text{ x } 5}$ or F = 810 lbs. which is the average push on the base of the bullet. As the base of the bullet is only .159 square inch this gives a pressure of $\frac{810}{.159}$ or 5,100 pounds per square inch average. Actually the pressure is a little higher than this, for some of it is used to overcome the friction of the bullet against the barrel; but the formula gives a very good idea of just what happens, and is perfectly satisfactory for obtaining approximate results. More elaborate formulae have been worked out, which take care of other factors, such as temperature, etc., but they would be out of place in a brief discussion such as this chapter.

The matter of powder gas expansion, discussed briefly above, is a very important factor in determining the barrel length that is necessary to use the powder properly. For example, the first .22 caliber Banker's Special with 2-inch barrel was made to order at my request. Some of my friends thought that I would get very little velocity with this gun; but actual tests showed a velocity of 1000 foot seconds with this 2-inch barreled revolver shooting the Remington high speed .22 cartridge. Almost everyone who has seen these figures has been astonished at this comparatively very high velocity, but if we go back to the fundamentals of interior ballistics and consider how many times its own volume gas in the cartridge is expanded before it leaves the barrel, we will see that this 2-inch barrel in the .22 corresponds to a 26-inch barrel in the

Springfield rifle. We arrive at this rather astonishing result in the following way:

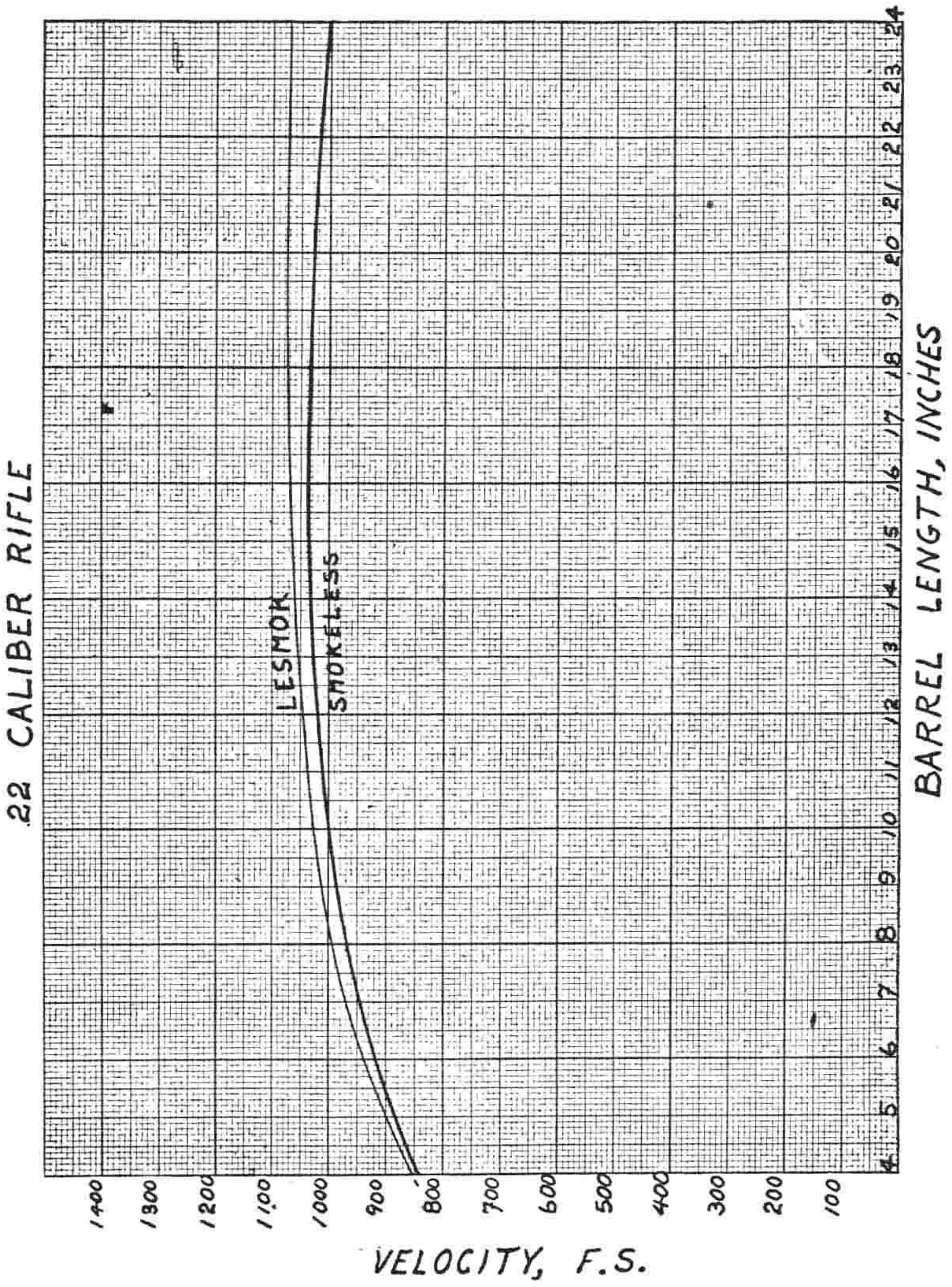
The Springfield rifle has a bottle-neck cartridge that is much bigger in diameter than the barrel. The powder space in the Springfield cartridge is .251 cubic inches and it takes 3.4 inches of the caliber .30 Springfield barrel to have the same cubic capacity. This means that when the bullet in the Springfield has gone 3.4 inches the gas which originally filled the cartridge case has been expanded to twice its volume, and when the bullet has gone all the way to the end of the 24-inch barrel in the Springfield, the gas has been expanded seven times.

The caliber .22 long rifle cartridge on the other hand, is not a bottle-neck cartridge. The powder space in this cartridge is the same diameter as the inside of the barrel, and just .43 inch long, so that when the bullet has moved forward .43 inch, the gas has expanded to twice its volume. In this 2-inch barrel revolver the gas expands about 7.7 times its own volume which is more expansion than the gas in the Springfield rifle has. In figuring the barrel length of a revolver, it is necessary to add the length of the cylinder which in this case is 1.3 inches. Thus the 2-inch barrel revolver in this caliber may be considered as having a barrel 3-1/3 inches long. A revolver with a cylinder 1.3 inches and a barrel 1.8 inches long would correspond in barrel length with the Springfield rifle and should use the powder with about the same efficiency.

I do not know whether or not most of our readers are acquainted with this fact, but with the average .22 rifle the longer you make the barrel the less the velocity, because in these very long barrels the gas has expanded so much that the pressure has fallen too low to do any useful work in pushing the already fast moving bullet and hence the barrel friction retards the bullet more than this comparatively low gas pressure accelerates it.

Numerous experiments have shown that with a fast burning powder, such as du Pont No. 93, ordinarily used in smokeless caliber .22 cartridges, the maximum velocity is attained at about 14 to 16 inches. Any longer barrel length just slows the bullet down, though, of course, it is useful for giving increased sight radius. With a slower burning powder, such as Lesmoke, the maximum velocity is attained with about a 16 or 18-inch barrel.

Therefore, with a 2-inch barrel revolver having a cylinder 1.3″ long, we might expect to get about 80% of the velocity that is in the powder, and with a 6-inch barrel revolver having a cylinder 1½″ long we might expect to get about 95% of the velocity that



Curve No. 1. The relation of barrel length to velocity in the .22 caliber rifle. This curve shows that with smokeless powder the maximum velocity with the .22 long rifle cartridge is obtained with a 16 inch barrel, and that additional length reduces the velocity. It also shows that the velocity in a ten inch pistol would be the same as that in a rifle with 24 inch barrel.

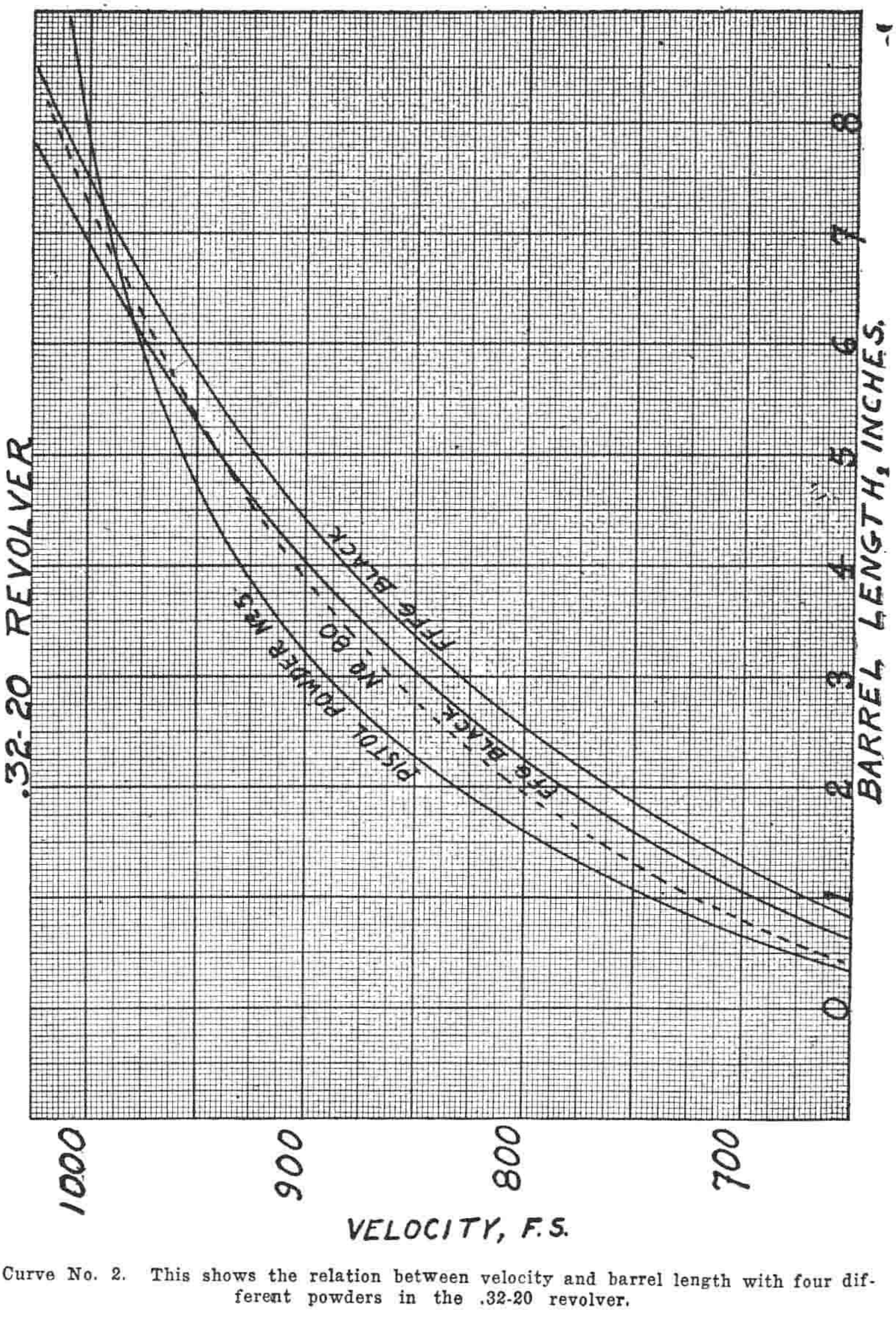
is in the powder. This is including the effect of leakage through the joint between the barrel and the cylinder; but in actual practice this leakage has been found to have small effect owing to the law of physics which says that a fluid or gas moving rapidly past an orifice has difficulty getting out.

For those of our readers who may be interested in the details of this subject, Curve No. 1 is included which shows the actual velocities obtained from tests of both Lesmoke and smokeless caliber .22 cartridges in a rifle having a 24-inch barrel which was cut off two inches at a time and the velocity taken for each length. This curve shows at a glance the reason for the well known efficiency of the 10-inch barrel target pistol, as with the ordinary caliber .22 cartridges the 10-inch barrel pistol gives nearly all the velocity that can be obtained from a cartridge under any circumstances.

This question of the number of expansions in a barrel of a given length shows that the larger the powder space in the cartridge case, the longer the barrel must be to use the powder efficiently. Cartridge cases with very compact powder space such as the .45 automatic pistol cartridge, are very efficient and therefore require only a short barrel. The .45 automatic pistol cartridge has a powder space which corresponds almost exactly to that in the caliber .22. The powder will fill .4 inch of the barrel which means that the 5-inch barrel of the .45 automatic pistol gives 12½ expansions or the same that would be obtained in a Springfield rifle with a barrel 42 inches long. Actually the barrel of the .45 automatic pistol need only be 2.8 inches long to be equivalent to the present Springfield 24-inch barrel.

On the other hand, the old style caliber .45 Colt cartridge is less efficient for use with modern high potential smokeless powders than is the .45 automatic. In the old Colt it takes about 78/100 inch of travel in the barrel to expand the powder space to double its size, hence a 5½-inch barrel added to the 1½-inch cylinder gives 9 expansions, corresponding to a 30-inch Springfield barrel. The 4-inch barrel of this gun added to the 1½-inch cylinder would give the same efficiency as the present 24-inch Springfield barrel.

The .38 Police Positive cartridge which is used in the small Post Office guns or the Banker's Special, has a powder space which is about equal in length to that of the .22. In other words, it, like the .22, takes about 43/100 inch of the barrel to expand the gas once. Hence the figures we gave above for the .22 showing that



Curve No. 2. This shows the relation between velocity and barrel length with four different powders in the .32-20 revolver.

the 2-inch barrel expands the gas 7.7 times, apply equally well to the Banker's Special.

The .38 Special on the other hand, has a little over 50% more powder space in the cartridge. This space is necessary in order to get a high velocity with the heavy bullet used in the .38 Special. It also means that a longer barrel is necessary to use the powder with equal efficiency.

To equal the 2-inch barrel in the Banker's Special as far as powder burning efficiency is concerned, the .38 Detective Special would have to have a barrel 3¼ inches long.

In making the investigation of this subject, I considered not only smokeless powder and Lessmoke powder but also in the large caliber revolvers Pistol Powder No. 5, duPont No. 80, and Black Powder of two different granulations, FFG and FFFG.

I plotted a lot of curves on this subject to show just what happens when the barrel of the revolver is cut off inch by inch, and strange to say, there very much·less difference between the black and the smokeless powders than the average reader would suspect. Our curves show that Pistol Powder No. 5 is a little quicker than either No. 80 or black powder. It also shows that the FFFG black is quicker than the FFG black which is an obvious fact as it has a smaller grain.

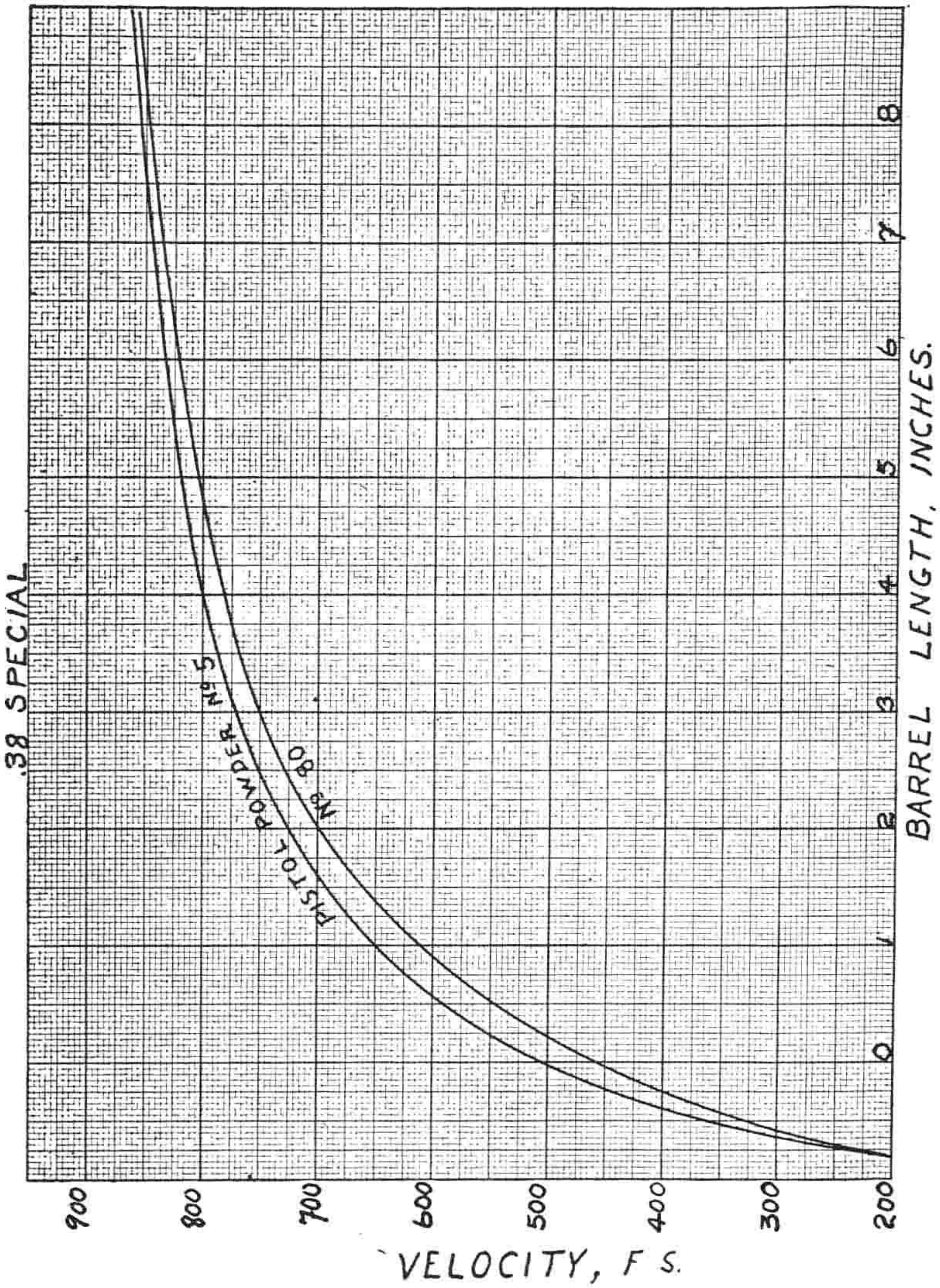
These curves, moreover, show very clearly the difference between a quick powder and a slow one. A quick powder gets more velocity in a short barrel than does a slow powder, but with a slow powder the ultimate speed when the barrel length is increased is greater.

There is included with this chapter curve No. 2 which shows velocity plotted against barrel length for .32/20 revolvers with four different powders. This curve shows that the speed of the powders is in the following order:

Pistol Powder No. 5
Sporting Rifle No. 80
FFFG Black
FFG Black

The caliber .32/20 is a revolver which has quite a large powder space, therefore it takes a long barrel to get all the velocity out of the cartridge. This curve shows plainly that with the 6-inch barrel in this caliber, there is still a considerable amount of velocity remaining, and a 7-inch barrel gives quite an increase.

Curve No. 3 shows the .38 Special loaded with No. 80. I plotted a curve for Pistol Powder No. 5 with the same gun and it



Curve No. 3. The effect of barrel length on velocity in the .38 Special Revolver.

is almost the same except that the velocity for the 1″, 2″ and 3″ barrels is a little higher and that for the 6″, 7″ and 8″ barrels is about the same. In plotting these curves I have taken the origin of the curve as the base of the bullet.

In investigating the velocities obtained with the 2-inch caliber .22 barrel, we obtained over 1000 f. s. with the Remington Palma Hi-Speed as was mentioned above. One series of experiments included comparative firing between a 2-inch barrel revolver, a 6-inch barrel revolver and a rifle with 28-inch barrel.

The following tabulation shows the results obtained, all the velocities being at 25 feet from the muzzle:

Cartridge	*Win. Lestayn*	*Rem. Kleanbore*	*Rem. HiSpeed Silvadry*	*Western Super-X*	*Rem. Palma HiSpeed*
Powder	*Lesmoke*	*DuP 93*	*Herc. 1300*	*Herc. 1300*	*DuP 93*
Vel. in 28″ Rifle	1022	1048	1216	1305	1244
Vel. in 6″ Rev.	887	904	934	1058	1141
Vel. in 2″ Rev.	740	780	762	879	997

In order to bring these results to muzzle velocities instead of instrumental velocities, it would be necessary to add about 25 feet.

It will readily be seen that there is very little difference in the performance between Lesmoke and the smokeless powder No. 93 which is ordinarily used in caliber .22 smokeless cartridges. It will be observed, however, that the more progressive burning powders used in the Remington Hi-Speed Silvadry and the Western Super-X are better adapted for use in a long barrel than they are in a short one. Their progressive quality which gives them high velocity in a rifle is a disadvantage when firing them in a short barrel gun.

I have taken the figures from this tabulation combined with previous figures obtained from firings in cut off rifle barrels and made them into a curve, No. 4 of those included with this chapter, which shows approximately the results and the relationship of these various powders. (Curve No. 4 is shown on page 154.)

It will be observed that in curve No. 1 the smokeless powder curve was below the Lesmoke curve, whereas in the No. 4 curve the smokeless powder is above the Lesmoke curve. This is merely due to the fact that in the first test the particular make of smokeless ammunition to be used happened to be loaded at a lower velocity than the Lesmoke, while the reverse was true in the ammunition used for the second test which was of a different make.

The important thing about these curves is not to show exactly how much velocity you will get, because this depends on what lot of ammunition you happen to use. The curves are intended to show the relation to velocity of one length of barrel to that of another.

All experience indicates that the best powder to use in a short barrel gun is the quickest powder, and in the caliber .22 this happens to be the ordinary smokeless and not the Lesmoke. In using Lesmoke with a short barrel Colt, there is a very noticeable flash and quite a loud report. In using the smokeless there is no flash noticeable and the report is mild.

Recoil and Jump

We saw at the beginning of our discussion of velocity that the maximum pressure in the .45 automatic pistol is about 14,000 pounds, and that the actual push on the base of the bullet, which has an area of about one sixth of a square inch, is in the order of one ton. We also saw that a similar pressure is exerted on the inside of the breech of the gun, for the gas presses equally in all directions, and not just on the bullet alone.

We also found how to calculate the velocity of the bullet from the formulae $v = \frac{Ft}{m}$ and $v = \frac{\sqrt{2FS}}{m}$. In the examples worked out, we were trying to find the velocity of the bullet, but these formulae give us the backward velocity of the gun also, if we use the mass, m, in the formula as that of the gun instead of the bullet. The gas moves the gun back at the same time that it moves the bullet forward, and the speed with which the gun recoils, or moves back, depends on the powder pressure and the weight of the gun. It also depends on the weight of the bullet, for if the bullet is very light, it gets away quickly, so that the pressure on the gun is released before the gun has had time to acquire much velocity. It is the very short time that the pressure lasts that keeps the recoil from being too great.

When you stop to consider that you are actually holding the pistol out there against a pressure of over a ton, you will realize how impossible it is for you to modify the recoil by holding against it. All that saves you from having the pistol torn from your grasp is the fact that the action lasts less than a thousandth of a second.

I once had an opportunity to fire some automatic pistols that had been converted to full automatic by a change in the sear.

This was at the beginning of the World War, when it was intended to mount these pistols in a fixed position in airplanes. The big surprise came when one of these guns was fired by hand. The gun operated so fast that the whole seven shots were gone in less than a second. In this case, the ton of pressure on the pistol was repeated seven times in rapid succession, and the result was that the pistol was swung violently upward, so that it finished the string of shots pointing almost straight up. A number of very strong men tried to fire it without letting it swing up in that manner, but it was impossible to modify the motion in any way.

As we have now made clear, there is a full ton of force exerted on the inside of the breech block, and as the hand which supports the gun, as well as the center of gravity of the gun itself, lies below the line of the barrel, the result of this strong force is not only to drive the gun backward, but to rotate the entire gun about a horizontal axis through the center of gravity, so that the muzzle tends to rise.

This is the explanation of something that has puzzled many of my correspondents. I have frequently been in receipt of questions of which the following is a sample: "My .38 Special Revolver is sighted for the factory loads, and when I shoot the 130 grain wad cutter bullet in my hand loads, my groups are all low. Please give me a load for this bullet that will make it group with the factory load." The answer to this problem, and all others like it is; "It can't be done."

And perhaps another correspondent will say: "In using the Western .38 Special Super Police cartridge, I find that it seems to group about five inches higher at 20 yards than the standard 158 grain load. What is wrong?" The answer is: "Nothing is wrong—except using bullets of two different weights in the same gun and expecting them to group together."

Now for the reason. We have seen above that the pressure of a ton or more on the inside of the breech of the gun, tending to push the gun suddenly backwards, operates in a line that lies above the center of gravity of the gun, and therefore tends to rotate the gun around a horizontal axis through the center of gravity of the gun so that the barrel moves upward. Thus the bullet, while it is moving forward is moving through a barrel that at the same time is rising. This motion is equivalent to giving the bullet an upward flip in addition to its forward motion. Thus the bullet will strike a point on the target that is above the point toward which the barrel was pointed when the trigger was pulled.

In making revolvers at the factory, this fact is taken into account and the sights are adjusted so that they are directed above the line of bore just the right amount to correct for this jump of the gun when it is fired, so that the bullet hits the spot to which the *sights* were pointed, though not the spot to which the *bore* of the gun was pointed at discharge. If we want to go at all into the mathematics of the jump of revolvers, we must remember what was said above, namely, that the powder pressure pushes backward on the gun exactly as hard as it pushes forward on the bullet, and that the only thing that keeps the gun from coming back just as fast as the bullet goes forward is its superior weight. If the gun and bullet weighed the same, the gun would go back as fast as the bullet goes forward, and the gun would have as much energy imparted to it as the bullet would receive, so that the shooter would be injured as much as the object his bullet strikes. Fortunately the average revolver weighs over 100 times as much as the bullet, and the velocities imparted to the gun and bullet respectively are nearly in inverse proportion to their respective weights: that is, $WV = wv$ where W and V refer to the weight and velocity of the gun and w and v refer to the weight and velocity of the bullet. This relation is not exact because the weight of the powder has a small effect and the blast of gas leaving the muzzle also increases the velocity of the gun; and the shooter's hand holding the revolver adds weight to it and reduces the recoil.

However, if we take any given revolver used by the same shooter, the weight of gun plus hand remains constant and velocity of recoil varies directly with wv, the weight of bullet times the muzzle velocity. This is the velocity of recoil, and as the *energy* of recoil varies with the square of the recoil velocity, it follows that in the case of the same gun used by the same shooter the *energy* of recoil varies with the square of the bullet weight and also the square of the velocity, or w^2v^2. Thus if we double the weight of the bullet keeping the velocity the same, we make the recoil four times as great; or if we keep the bullet weight the same and double the velocity, the result is the same. With the same velocity, the 200 grain .38 Special bullet would give 75% more recoil than a 150 grain bullet in the same gun. With the .38 Special Super Police bullet, 200 grains at 725 f. s., the recoil is only 14 per cent greater than with the regular 158 grain .38 Special with 860 f. s., as the higher velocity of the regular load nearly compensates for the lighter bullet.

But in spite of the fact that the recoil is nearly the same, the slower 200 grain Super Police strikes 4½ inches higher at 20 yards. This is because it is not the total recoil that affects the position of the group on the target. It is only that part of the recoil that takes place before the bullet has left the barrel that displaces the groups, and as was mentioned before, this part of the recoil is independent of the velocity because the greater the velocity the greater the recoil, but at the same time, the sooner the bullet is gone.

On appealing to mathematics for an exact formula it is found that the part of the recoil that takes place before the bullet has left is proportional to the bullet weight and the barrel length and inversely proportional to the weight of the gun, or in other words is proportional to $\frac{wL}{W}$. But for any given gun the barrel length and the weight remain constant, so that the jump before the bullet leaves is proportional solely to the bullet weight w.

No doubt most shooters realize this, but what many do not know is what factors are responsible for the jump and what will change it. The general impression seems to be that if we put in a heavier charge of powder we will make the jump greater and thus make the bullet hit higher on the target, but this is not so. It is true that a higher velocity will neutralize some of the drop in trajectory, but it will not affect the jump. At 20 yards, the difference in the drop of the trajectory between the Western Super Police .38 Special with 200 grain bullet and 710 f. s. velocity and the factory load with 158 grain bullet and 860 f. s. is 4/10 inch, while the difference in point of impact due to jump is 4½ inches. The impossibility of making the 158 grain bullet strike as high as the 200 grain Super Police is further shown by the fact that the total trajectory drop of the 158 grain bullet at standard velocity at 20 yards is only 9/10 of an inch. Even if we raised the velocity to 2000 f. s. we should have raised the point of impact by only ¾ inch and the low velocity Super Police would still shoot nearly four inches higher.

Of course, raising the velocity of the 158 grain bullet would greatly increase the recoil of the gun, but on the other hand, at the higher velocity the bullet would get away much sooner, and a mathematical investigation will show that these two factors exactly balance each other and for a given bullet weight the amount the gun moves before the bullet leaves is exactly the same regardless of the velocity.

In trying to get an actual example to illustrate what has been said, I remembered shooting a number of hand loads with bullets of different weights several years ago, and a search through a notebook showed a record of ten shots each fired off-hand at 20 yards outdoors at the standard American 20-yard target, with .38 Special, .38 Special Super Police and .38 Long Colt factory loads; also with hand loads including four different bullet weights and three different powder charges for each.

The hand loads included the 154 grain Bond wad cutter, the 163 grain round point, the 177 grain flat point, and a 210 grain bullet shaped just like the Super Police. These were loaded with 4 grains of duPont No. 5, also with 4½ grains, and the 163 and 177 grain bullets were also tried with 5 grains, though this was too heavy a load to be safe for all conditions.

The firing was done with a Smith & Wesson Military & Police, 6-inch barrel, fixed sights. No range was available that day, so the targets were nailed up on a tree in the woods, and 20 yards measured off with a steel tape. The wind was blowing, the light was spotty (sunlight through trees), and the shooting was done off-hand, so the results could hardly be expected to be perfect, yet when the results were dug up two years later and the vertical location of the groups just as they stood in the notes, were plotted against bullet weights, the points fell almost exactly on a straight line, indicating complete agreement between the mathematical theory stated above and the results obtained through actual test.

The notebook data used was as follows:—

Height of Group in Inches Above Point of Aim

Factory Loads

.38 Long Colt	150 gr. bullet	— .08
.38 Special	158 gr. "	+ .20
.38 Super Police	200 gr. "	+4.50

Reloads

	4 Gr. #5	*4½ Gr. #5*	*5 Gr. #5*
154 Gr. Wad Cutter	+ .36	+ .22	
163 Gr. Round Point	+1.65	+1.54	+ .83
177 Gr. Flat Point	+2.26	+2.62	+2.96
210 Gr. Super Police	+6.07	+6.28	

Several years ago the late Capt. Philip P. Quayle, of the Peter's Cartridge Company made a study of the phenomena of jump by the aid of spark photographs of bullets coming out of the muzzles of the revolvers. The gun muzzle was rested on a wooden support and the photographs showed that in the case of the .38 Special, the muzzle had actually raised nearly 1/10 inch from the support, even when strenuous efforts were made to hold it from rising. In fact, a little consideration will show how futile any such attempt to *hold against* recoil would be; for if you were holding the muzzle of the gun pointed aloft and had the whole weight of an automobile, for example, dropped on the muzzle, you could do nothing toward holding it. In firing the revolver, of .45 caliber, a push equalling the weight of a small automobile is applied directly backwards, and keeps pushing for nearly a thousandth of a second. While this weight is operating, it will have its way, regardless of how hard you hold against it. Capt. Quayle found that the most strenuous efforts to hold the muzzle down on the support failed to keep it from rising enough to throw the bullet 14 inches above the line of bore at 20 yards; and the difference between holding as hard as possible and not holding at all was only a change of ½ an inch in the location of the bullet at 20 yards.

Theory of Recoil

When a gun is fired, the pressure of the gas acts backward on the gun equally as strongly as it acts forward on the bullet.

When a force acts on a movable body, the velocity that is given to the body in feet per second is equal to the force in pounds, multiplied by the time during which its acts, and divided by the mass of the body; or in other words, $v = \frac{Ft}{m}$. Where m is the mass of the movable body, F is the force in pounds, and t is the time during which it acts.

Now in a gun, it is quite obvious that the time during which the force acts on the gun is the same as the time during which it acts on the bullet; for when the bullet goes out of the barrel the gas stops acting on both the gun and the bullet at the same time. Also the force on the gun is the same as that on the bullet, for the gas pushes equally in all directions, backward as well as forward.

If we call the velocity of the bullet v
the mass of the bullet m
the velocity of the gun V
the mass of the gun M

Then the forward motion of the bullet will be $v = \frac{Ft}{m}$ or $Ft = vm$

and the backward motion of the gun will be $V = \frac{Ft}{M}$ or $Ft = VM$

Thus we see that Ft, or the powder pressure on the base of the bullet, multiplied by the time during which it acts, is equal to the bullet velocity multiplied by the bullet mass, and is also equal to the recoil velocity of the gun multiplied by the mass of the gun. This also tells us that $VM = vm$, or the velocity of the gun times its weight is equal to the velocity of the bullet times its weight. (Weight is proportional to mass; mass is the weight in pounds divided by the acceleration of gravity, 32.2). Also, moving M over to the other side of the equation, we have $V = \frac{\text{ɯʌ}}{M}$, or, in other words, the recoil velocity of the gun equals the bullet velocity times the bullet weight, divided by the weight of the gun.

Thus for example, if we have a .38 Special gun, weighing 2 pounds, and it shoots a bullet weighing 158 grains with a velocity of 860 feet per second, we would expect the gun to have a recoil velocity of 860 divided by the weight of the gun, and multiplied by the weight of the bullet in pounds. As there are 7000 grains in a pound, the bullet weighs 158/7000ths of a pound, hence the recoil velocity would be $\frac{860}{2} \text{ x } \frac{158}{7000}$, which works out to 9.7 foot seconds.

This is the *velocity* of recoil; but we are more interested in the *energy* of recoil than we are in the velocity. The weight of the gun, combined with the velocity is what makes it hard to hold. Velocity in itself does not mean much without weight. Thus a tennis ball coming very fast is easy to stop; it has velocity but not much weight. A baseball has more weight, and at the same velocity would obviously be much harder to stop.

The energy of the recoil of a gun is equal to one half the mass of the gun times the square of the recoil velocity, or $\frac{1}{2} MV^2$. The mass of the gun is the weight divided by the acceleration of gravity, or 2 pounds divided by 32.2; and the velocity squared is 9.7 multiplied by 9.7, or 94.09. Hence the recoil energy would be $\frac{1}{2}$ of $\frac{2}{32.2}$ 94.09, or 2.9 foot pounds.

However, in figuring recoil in this manner, there is something neglected, and that is the fact that the explosion not only drives out the bullet, but the powder charge as well. When the explosion started, the bullet was in the cylinder, and the powder charge was lying behind it in the cartridge; when the recoil has finished, the bullet and the powder charge have both gone out of the gun with extreme rapidity, and the work of driving out the powder is added to that of expelling the bullet, and has its effect in adding to the recoil. This could be taken care of by merely adding the weight of the powder charge to the weight of the bullet in our formula as given above; but the sudden expansion of the gas as it leaves the barrel has a reaction that is greater than is accounted for by the weight of the powder, so that a more nearly correct result is obtained by adding one and a half times the weight of the powder charge to the weight of the bullet in figuring the recoil.

In smokeless loads, where the weight of the powder is small in relation to that of the bullet, it makes relatively little difference whether or not the powder is figured in; in the .38 Special which we figured out above, the smokeless charge is only 3.6 grains, and adding one and a half times this weight, or 5½ grains to the bullet weight would make our recoil energy 3.15 foot pounds instead of 2.9, a difference of only about 8 percent. But in black powder loads, where the charge runs up to 30 or 40 grains, instead of from 3 to 5 as with smokeless, the difference in recoil is very considerable. This is the reason why black powder gives a much heavier recoil than smokeless. Very few shooters have realized the reason for this fact. As an example, take the .38 Special cartridge loaded with 22 grains of black powder. Adding one and a half times the weight of powder charge to the bullet weight would mean adding 33 grains to our 158 grain bullet, giving an equivalent bullet weight of 191 grains. This would give a recoil velocity of 11.7 f. s., and a recoil energy of 4.27 foot pounds, an increase of 36 percent over the recoil of the smokeless load.

By looking again at the formulae given above, it will be seen that the weight of the gun has an important bearing on the recoil. If instead of using a .38 Military and Police Revolver, weighing 2 pounds, we had used a .38 Police Positive Special, weighing only 22 ounces, the recoil with the smokeless load would be 4.7 pounds instead of 3.15 pounds. Thus every different load gives a different recoil, and the same load gives a different recoil in guns of different weights.

To understand just what the figures quoted above mean, it may be considered that a foot pound is the energy that is necessary to lift a pound one foot, or the energy that a pound weight will gain by falling from a height of one foot. Thus the recoil of the .38 Special, 3.15 foot pounds, should feel about the same to the hand as catching a one pound weight which has fallen from a height of 3.15 feet.

RECOIL TABLE

Name of Gun		*Weight*	*Cartridge*	*Powder*	*Bullet weight*	*Velocity*	*Recoil energy*
.45 Colt New Service	7½ inch	42 oz.	.45 Colt, Remington	40 grains	255 grains	910 f. s.	9.9 ft. lbs.
.45 Colt New Service	5½ "	39 "	same	same	same	same	10.7 "
same		same	.45 Colt smokeless	4.6 grains	same	770 f. s.	5.32 "
.45 Colt Model 1917	5½ "	same	.45 A. C. P.	4.6 "	230 grains	810 "	4.8 "
.45 S. & W. 1917	5½ "	36½ oz.	same	same	same	same	5.2 "
.45 Automatic	5 "	39 oz.	same	same	same	same	4.50 "
.44 S. & W.	6½ "	38 oz.	.44 S. & W. Special	6.3 "	246 grains	770 f. s.	5.2 "
.38/44 Smith & Wesson	6½ "	41.75 oz	.38 Special High Velocity	6 "	158 "	1100 "	4.0 "
same	same	same	.38 Special	3.6 "	same	860 "	2.4 "
.38 Military & Police	6 inch	32 oz.	same	same	same	same	3.3 "
same	same	same	.38 Special High Velocity	6 grains	same	11 f. s.	5.4
.38 Officer's Model	same	34 oz.	same	same	same	same	5.1 "
same	same	same	.38 Special	3.6 grains	same	860 f. s.	3.1 "
.38 Police Pos. Spl.	4 inch	22 oz.	.3 same	same	same	same	4.7 "
same	same	same	.38 Special High Velocity	6 grains	same	1100 f. s.	7.8 "
.38 Police Positive	same	20 oz.	.38 Colt New Police	2.4 "	150 grains	710 "	3.0 "
.38 Regulation Police	same	18 oz.	same	same	same	same	3.4 "
.32 Police Positive	same	20 "	.32 Colt New Police	2.1 grains	100 grains	760 "	1.6 "
.32 Hand Ejector	same	18 oz.	same	same	same	same	1.7 "
.22 Model K S. & W.	6 inch	35 "	.22 long rifle	2 grains	40 grains	938 f. s.	.2 "
9 MM Luger	4 "	31.3 oz.	9 MM Luger	4 "	125 "	1040 "	3.1 "
.30 Cal. Luger	4½ "	31.3 "	7.65 MM Luger	4 "	93 "	1180 "	2.2 "
.30 Caliber Mauser	5¼ "	45 oz.	7.63 MM Mauser	5 "	85 "	1323 "	1.7 "

CHAPTER 9

EXTERIOR BALLISTICS

THE subject of exterior ballistics is the study of the motions of bullets after they have left the gun. It is a very complicated subject, and requires many mathematical tables and formulae. In this chapter we will not make any attempt to go into that phase of the subject. There are books on it that are available for those who are interested. However, there are several things that almost anyone who is interested in shooting will want to know about his gun and the bullet it shoots, such as the velocity, the energy, the penetration, etc., and these all come under the general heading of exterior ballistics. In this chapter we will give some of the most pertinent data of that kind about the popular pistol bullets.

Velocity

One of the most important things to know about a gun is the velocity with which it shoots. This is measured by an instrument called a chronograph. There are several forms of chronograph; the most commonly known and used is the Boulongè chronograph. This consists of two metal rods held up by electro-magnets. The first rod, or registrar, is held by an electro-magnet energized by a current of electricity passing through a wire just in front of the muzzle of the gun. When the gun is fired, the wire is broken by the bullet, and the current stops, so that the magnet drops the rod. There is another rod or weight, held by a magnet energized by current passing through a wire that is connected to the target fifty feet (or some other measured distance) from the first wire. When the bullet hits this second wire, it drops the other rod, and it strikes the trigger of a knife that marks the first rod, which is still falling.

To get the zero mark, or disjunction, as it is called, both rods are dropped at once by pressing a key which opens both circuits.

Then the rods are hung up again, and the shot is fired. It hits the muzzle wire and the first rod starts to fall. An instant later the bullet strikes the second wire and the second rod falls and makes a mark on the first rod. When the rods fall together, the mark is at the zero point, but when one falls before the other, there is a difference between them that is the distance the first rod fell before the other one started. By measuring this distance the time it took the shot to pass from the first wire to the other is calculated, and as the distance between the wires is known, the velocity is easily found.

The velocities thus obtained are not muzzle velocities, however, for this procedure merely gives the average velocity over the distance from the muzzle wire to the target wire. If the wires are located with the first one three feet from the muzzle, and the other one fifty feet further along, as is often the practice, the velocity thus obtained will be correct for the point midway between the wires, or 28 feet from the muzzle. The reason for placing the first wire 3 feet in front of the muzzle is to get it out of the blast of the escaping gases.

A velocity obtained in this manner is called *instrumental* velocity, and is always lower than the muzzle velocity, for the bullet is slowed up to a certain extent by the air resistance in traveling over the space between the wires. The amount of this slowing up can be calculated by means of ballistic tables, and it depends on the muzzle velocity and the weight and shape of the bullet, so that it varies from one bullet to the next, but for most pistol bullets a very close approximation to the muzzle velocity can be obtained by adding three per cent to the instrumental velocity at 25 feet.

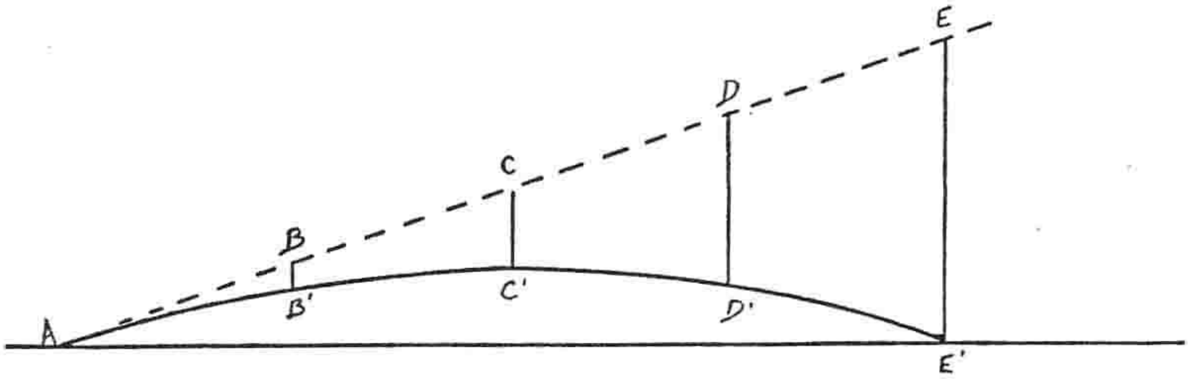
For rifles, the first and second wires are usually separated by 100 or 150 feet, giving instrumental velocities at 53 feet or at 78 feet. For pistols, the instrumental velocity is usually taken with the first wire right at the muzzle, and the second one 50 feet away, so that the velocity is correct for a distance of 25 feet from the muzzle.

The Trajectory

When a bullet leaves a gun, it does not move in a straight line, but in a curve, which is called the trajectory. See sketch.

The reason for the fact that the bullet moves in a curve is that while it has a forward motion given to it by the gun, it also has a falling motion imparted to it by the force of gravity.

Thus the curve of the trajectory results from the fact that as soon as the bullet leaves the gun, it starts to fall, the same as any other unsupported object. In the first second, it falls 16 feet, in the next one 64 feet, and so on, the amount of drop in feet for a bullet or any other falling body being equal to the square of the time in seconds, multiplied by one-half the acceleration of gravity, (approximately 32). This is expressed by the formula $h=\frac{1}{2} gt^2$, where h represents the distance the body falls, g represents the acceleration of gravity, and t the time in seconds that the body has been falling. As g is approximately 32, this formula reduces to $h=16 t^2$. Thus a bullet dropped out of a window will drop 16 feet in one second, 64 feet in two seconds, 144 feet in three second, etc.



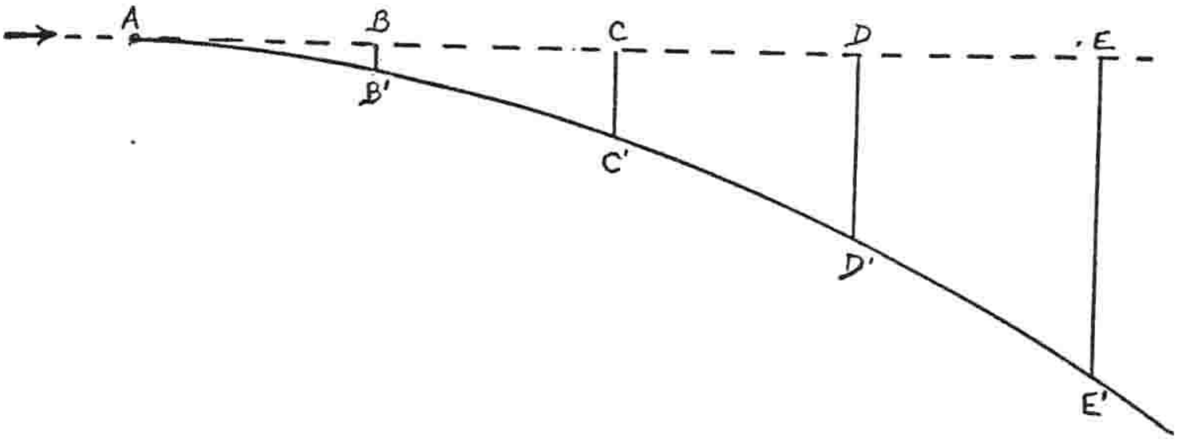
The trajectory of a bullet. In order to hit the point E', the bullet is fired in an upward direction along the dotted line A-E, and the angle, E-A-E' that this line makes with the horizontal, is the angle of departure. If B, C, D, and E are located at distances from A as indicated, the bullet will not pass through these points, but through other points located below them, the difference being due to the action of gravity during the time of flight to the points in question. The distance from A to E' is called the range.

Thus if a bullet is fired horizontally, it will have dropped 1 foot below the line of bore in one quarter of a second; four feet at the end of a half a second; 9 feet at the end of ¾ of a second; 16 feet in one second, and so on. It is this that limits the range of bullets. As soon as they get out of the gun, they begin to fall, and the problem is to move them as far as possible before they get to the ground.

This is partly solved by shooting the bullets slightly upward, instead of horizontally. For example, if we want to shoot a man who is 120 yards away with the .45 automatic pistol, it will take the bullet about ½ second to get there. This will give the bullet time to drop 4 feet, so that we must point the pistol at a point four feet above him.

However, this is not all. The bullet slows up from the resistance of the air. Take for example the Super .38 Automatic, which has a muzzle velocity of 1200 feet per second. In one-fourth second it would go 100 yards if it didn't slow up, and we would expect the drop at 100 yards to be 12 inches. But actually, we find it to be 14 inches. Evidently the bullet takes longer than ¼ second to go 100 yards. And the drop at 200 yards, instead of being 4 feet, is found to be 66 inches. Working our equation for drop backwards, we find that the bullet took .27 seconds to go 100 yards, and .58 seconds to go 200 yards. That gives an *average* velocity over 100 yards of 1108 f.s. instead of 1200, and as the velocity at the start was 1200, we are forced to conclude that the final velocity on passing the 100 yard mark was 1030 f.s.

This loss of velocity, or slowing up, is caused by the resistance of the air on the front end of the bullet. There is a difference in this resistance depending on the shape. A sharp pointed bullet will have less air resistance than one which is blunt or square across the front. In ballistics this difference in resistance due to shape is measured by a quantity called the "Form Factor," denoted in the ballistic formulae by "i".



This diagram shows what happens when a bullet is fired horizontally. Suppose that a bullet is fired along the horizontal dotted line from A toward E. If the bullet has such a speed that without the action of gravity, it would reach the point B in ¼ second, it will actually pass one foot below that point, for a body which is dropped will fall 1 foot in the first quarter of a second. Thus the bullet will pass through B′, one foot below B. Likewise, if A-C represents the distance corresponding to a time of flight of ½ second, A-D to ¾ second, and A-E to one second, the bullet will pass through C′, D′, and E′, which are 4 feet, 9 feet, and 16 feet, respectively, below the corresponding points on the horizontal line. The drop for any range is equal to the distance that a body will fall in the time of flight, and this drop in feet equals 16 times the square of the time of flight in seconds.

Another important factor is the proportion of the diameter to the weight. The weight is what gives the bullet power to carry along its velocity, while the area with which it bores through the air causes its resistance.

Some bullets have more diameter in proportion to their weight than others. Thus, a .30 caliber Krag rifle bullet weighs 220 grains, or nearly as much as the 230 grain .45 caliber pistol bullet. But the area of the cross section of the Krag bullet is only .075 square inch, while that of the .45 automatic pistol bullet is .159, or over twice as much, so that the .45 pushes along more than twice as much air as the .30 caliber Krag, or any other .30 caliber bullet, for that matter; yet the Krag bullet has just about as much weight to use to do the pushing with. For this reason the air will slow the .45 caliber bullet more quickly than it will the .30.

As was said above, the force which causes the bullet to carry through against the air resistance is the weight, and the surface against which the air pressure pushes in holding it back is the cross-sectional area, which is proportional to the square of the diameter. Thus a measure of the ability of a bullet to hold its velocity is the "Sectional Density," which is the carrying power, or weight, divided by the retarding area, or the square of the diameter. To find the sectional density of any bullet, divide the weight (in pounds) by the square of the diameter in inches. Expressed as a ballistic formula, sectional density equals $\frac{w}{d^2}$.

However, the sectional density does not tell the whole story, for the shape of the point has its influence. The sectional density combined with the form factor "i" does tell the whole story, however. A bullet in which this quantity, (called the "Ballistic Coefficient," or "C") is larger than that of another bullet will hold its velocity better. "C" equals the sectional density divided by the form factor, or $\frac{w}{i\,d^2}$.

The table below gives the sectional density, form factor, and ballistic coefficient for several popular pistol cartridges.

Name of cartridge	*Bullet weight grains*	*Bullet diameter inches*	*Sectional Density*	*Form Factor "i"*	*Ballistic Coefficient "C"*
.25 A. C. P.	50	.250	.114	1.10	.103
.32 S. & W.	85	.314	.1235	1.10	.112
.44-40	200	.426	.158	1.32	.120
.32 A. C. P.	74	.314	.1085	.96	.123
.41 short	160	.400	.142	1.12	.127
.38-40	180	.400	.161	1.25	.128
.22 long rifle	40	.224	.115	.90	.129
.38 long Colt	150	.359	.167	1.26	.132
.32 Colt N. P.	100	.314	.145	1.04	.139
.38 S. & W.	145	.359	.161	1.10	.145
.41 Long	195	.388	.185	1.18	.157
9 MM Luger	125	.354	.142	.87	.163
.38 Super A. C. P.	130	.359	.144	.84	.172
.45 Colt	255	.455	.176	1.00	.177
.30 Mauser	86	.309	.129	.72	.179
.44 Special	246	.431	.184	.98	.188

Name of cartridge	*Bullet weight grains*	*Bullet diameter inches*	*Sectional Density*	*Form Factor "i"*	*Ballistic Coefficient "C"*
.45 Auto	230	.451	.162	.86	.180
.30 Luger	93	.309	.139	.72	.194
.38 Special	158	.359	.175	.89	.197

These figures are taken from actual ballistic tests, but should be considered only an approximation, as only a few firings in each cartridge were made, and exhaustive tests might indicate some changes. It will be noted that the cartridges are arranged in the order of the ballistic efficiency, the most efficient coming last.

For rifle bullets, these ballistic factors, such as the sectional density, the form factor, and the ballistic Coefficient "C" are very important, because rifles are used for long ranges of from three or four hundred yards up to a thousand yards or more, and it would be impossible to hit anything at these long ranges unless the ballistic data were known, so that the sights could be graduated correctly for the different ranges.

However, for revolvers, where the range usually does not exceed 50 yards, a knowledge of exterior ballistics is not so important. It is interesting, just the same, to see how much the various bullets will drop at ranges up to about two hundred yards, for many of the higher velocity revolvers, such as the .38/44 can do good work at ranges of 150 to 200 yards, and the owner of such a gun will find it useful to know how much he will have to aim above the target to make a hit.

The drop in feet for any range can very easily be calculated by the formula, drop in feet equals sixteen times the time of flight squared; and the drop in inches is twelve times this, or 192 times the square of the time of flight. If the bullet takes a half second to go 150 yards, the drop in inches will be 192 x ½ x ½, or 48 inches. This is the actual figure for the .38-40. Remember these two formulae:

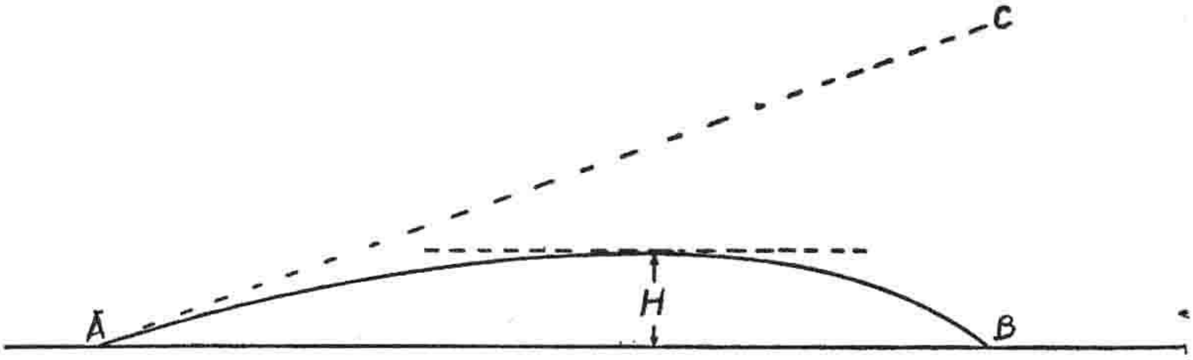
Where t represents the time of flight in seconds,

Drop of the bullet in feet $= 16\ t^2$

Drop of the bullet in inches $= 192\ t^2$

It is interesting also to know that the time of flight can very easily be obtained from the height of the trajectory for any range, which is usually given in gun catalogs in the ballistic tables for the cartridges described in the catalog; for H, the height of trajectory *in feet* at its highest point equals 4 times the square of the time of flight. Thus the height for the 150 yard trajectory of the .38-40 cartridge is 4 T^2, or 4 x ½ x ½, or 1 foot. And note also, that the drop for any range is four times the maximum height of trajectory for that range. The drop for the .38-40 at 150 yards would thus be 4 feet, or 48 inches.

Most pistol bullets drop from about ½ inch to about 2 inches at 20 yards, and from 3 to 9 inches at 50 yards, depending on the muzzle velocity. The ballistic coefficient "C" has some little effect, but not much. Thus we can get a very close approximation to the drop by dividing the range in feet by the velocity, to get an approximate time of flight, and then by taking 192 times the square of this figure for the drop.



This diagram illustrates what is meant by the "height of the trajectory" for any range. This term is of frequent occurrence in gun catalogs in connection with tables giving the ballistics of cartridges. In the sketch, A is the point from which the gun is fired, and B is the target. A-B is the range. The dotted line A-C is the line of departure, or the direction in which the bullet must be started to hit the object B. H, the highest that the bullet rises above the ground in its flight to the target is the "height of the trajectory" for that range. The time of flight for the range A-B is equal to the square root of four times the height of trajectory in feet, and the drop of a bullet at any range if fired horizontally, is four times the height of the trajectory for that range.

For example, take the .38-40. The veloctiy is 986 f.s., and if it did not slow down any, it would go 150 yards, or 450 feet in $\frac{450}{986}$ or .46 second.

The drop in inches would be 192 times .46 squared, or 41 inches. Actually it is 48, the difference being the amount that the drop increased owing to the slowing of the bullet by air resistance.

An even closer approximation, which is nearly enough correct for every practical purpose can be obtained by reducing the velocity used in this calculation fifty feet for every hundred yards of range. Thus for 150 yards we would reduce the velocity 75 feet, and use 911 instead of 986 feet. This would give a drop of 47 inches.

It is interesting to note that the way in which revolvers are sighted automatically neutralizes part of the drop. Most revolvers are sighted to shoot into the center of the bull's-eye at 20 yards when aiming at the bottom of the bull's-eye. The center is 1.36 inches above the bottom, so that the sights are adjusted to make the bullet go this much up the hill, so to speak, above the point aimed at. But this is not all. The front sight is about .6 of an inch above the line of bore, so that the bullet starts from this much below the line of sight and finishes 1.36 inch above it at 20 yards. But even this is not all, for the bullet drops .75 inch in going 20 yards, so that the total rise that the sights must give it to overcome all these factors is 2.71 inches. In other words it is started in such a direction that it would rise 2.71 inches in 20 yards if gravity and other factors did not neutralize part of the rise. If it were not for gravity, the bullet would rise 2½ times as far, or 6.75 inches at 50 yards, and ten times as far, or 27 inches at 200 yards.

The rise of 6.75 inches at 50 yards is partly neutralized at 50 yards by the drop, which is about 4 inches, on the average, so that the bullet will strike about 2½ or 3 inches above the bottom of the 8 inch bull, or nearly in the center.

At 100 yards, the rise will be about 13 inches, and the drop about 20, so that the average gun will shoot perhaps 7 inches low. At 200 yards, it will shoot over 6 feet low for the .38 Special, but only a little over 3 feet low for the .38/44.

Of course some of these factors vary a little for the various guns, and the differences as given above can be figured more closely for each individual gun, by taking the correct figures for that particular gun.

So that the reader may do any figuring along this line that he pleases, I have included here a table giving the ballistic coefficient, and the muzzle velocities and remaining velocities and drop in inches at 25, 50, 100, 150, and 200 yards for most of the leading pistol cartridges.

These figures are based on firings for retardation and drop at several ranges, and are approximately correct. However, it is only fair to state that there are slight differences even when the same cartridge is fired twice, so that a small variation from the figures given must be expected, as is usually the case with ballistic and other experimental data.

REMAINING VELOCITIES AND DROP IN INCHES FOR VARIOUS RANGES

Name of Cartridge	"C"	Remaining velocities in f.s.						Drop in inches				
		Muzzle	25 Yds.	50 Yds.	100 Yds.	150 Yds.	200 Yds.	25 Yds.	50 Yds.	100 Yds.	150 Yds.	200 Yds.
.30 Mauser	.18	1323	1256	1197	1105	1036	981	.65	2.75	12	29	55
Super .38 A.C.P.	.18	1190	1139	1096	1026	971	924	.78	3.37	14.4	33	66
.30 Luger	.194	1173	1130	1093	1031	981	939	.81	3.35	14.4	34	64
.38/44 Special	.16	1100	1060	1027	967	914	867	.94	3.8	16.6	37	69
9 mm. Luger	.163	1040	1008	979	930	885	844	1.0	4.2	17.8	43	77.5
.38-40	.128	986	953	923	867	817	773	1.15	4.7	20	48	92
.32 A.C.P.	.123	965	933	901	847	798	754	1.2	5.2	21	51	96
.32-20	.186	954	933	912	874	837	806	1.2	5.1	20.8	49	90
.22 Long Rifle	.129	950	920	892	840	794	752	1.2	5.1	21.6	52	97
.44-40	.120	918	888	859	808	762	719	1.3	5.5	23.5	56	103
.38 Special	.197	860	844	828	798	770	743	1.5	6.0	25	59	108
.45 A.C.P.	.18	810	794	778	750	720	693	1.7	7.1	26	64	123
.45 Colt	.177	790	775	759	729	701	674	1.76	7.2	30.8	70	131
.44 Special	.124	780	766	732	724	698	672	1.8	7.4	31.2	72	132
.25 A.C.P.	.103	745	720	696	650	607	567	2.0	8.3	35	86	166
.32 Colt N.P.	.139	730	712	694	660	628	597	2.1	8.6	36	85	158
.41 Long	.157	715	699	684	654	625	598	2.16	8.8	37	91	163
.38 Special Super Police	.177	710	696	682	656	630	606	2.16	8.85	37	90	161
.41 Short	.127	710	690	672	636	602	570	2.20	9.0	38	92	172
.32 S. & W.	.112	635	616	596	560	526	494	2.7	11.6	48	115	220
.38 S. & W.	.145	632	617	603	574	547	521	2.65	11.0	47.6	112	208

Bullet Energy

The power possessed by a moving bullet, or in other words, its ability to keep going when it meets an obstacle, and to do work on the obstacle is of immense importance, for obviously, the more power a bullet has, and the harder it is to stop, the more effective it can be as a weapon.

When any object is set in motion, it acquires what is called kinetic energy; that is, the energy of motion. A moving object tends to keep on moving, and the heavier it is, or the faster it moves, the harder it will be to stop. For example, a bullet that weighs 200 grains will be twice as hard to stop as one that weighs 100 grains, and is moving at the same speed. Thus the energy of bullets varies directly as the weights of the bullets.

Velocity, however, works differently; if two bullets have the same weight, and one is moving twice as fast as the other, it will be not twice as hard to stop, as might be expected, but four times as hard. And if a bullet is moving three times as fast as another of the same weight, it will be nine times as hard to stop. Thus the energy varies with the square of the velocity.

In order that the relative power of the different bullets may be known to the users, it is common for catalogs and ballistic tables to note for each bullet listed the Muzzle Energy, which is the kinetic energy possessed by the bullet when it leaves the muzzle. Like the velocity, the energy falls off as the bullet moves along its trajectory.

Energy is measured in foot pounds, and one foot pound means that amount of energy which would be capable of lifting a weight of one pound through a distance of one foot. Ten foot pounds would be capable either of lifting one pound ten feet, or ten pounds one foot. If a one pound weight is dropped ten feet, or a ten pound weight is dropped one foot, it will acquire such a velocity in falling that it will acquire ten foot pounds of energy.

Whenever an object has motion, it will keep on moving until some force stops it. If we had an object moving with an energy of ten foot pounds, and we applied a pressure of one pound against it to stop the motion, it would move ten feet before it came to a full stop. Moving against an opposing force is work, and the total amount of work done is equal in physics to the force in pounds multiplied by the distance in feet. A moving object which has a force resisting its motion will continue to move until the work it has done against the force is equal to the total energy it had.

Thus the air pressure on the nose of the .45 Automatic Pistol bullet over the first hundred yards of its flight is equal to about 2.46 ounces. During the 100 yards, or 300 feet, of its motion, this will take out 2.46 times 300, or 728 foot-*ounces* of energy, and dividing by 16 to bring this to pounds, we have 46 foot pounds of energy lost.

The same bullet will penetrate 10 inches, or 10/12th of a foot, of moist loam. The force on the nose of the bullet to stop it in this distance is the total energy divided by the distance in feet, or 337 divided by 10/12th, which equals 405 pounds. As the bullet has a cross-sectional area of only .159 inch, this force on the nose is equivalent to 2550 pounds per square inch.

Looking back into the last chapter, it will be found that we told how to find out the average push on the base of the bullet by figuring back from the muzzle velocity. Now if a bullet is moving 810 feet per second, or at any other velocity, and a force stops it in ten inches, the same force applied to a stationary bullet for ten inches will give it an equal velocity. Thus the force that will stop a bullet going 810 f. s. in ten inches, if applied to the base of the bullet in a ten inch barrel would give the bullet 810 f. s. muzzle velocity.

To check up on our mathematics, let us figure the matter out in that way and see if the pressure works out the same. We saw in the last chapter that the force on the base of a bullet equals mv divided by 2s, where m is the mass of the bullet, v is the muzzle velocity, and s is the barrel length in feet.

With a ten inch barrel, a 230 grain bullet, and a muzzle velocity of 810 f. s. we would have $F = \frac{230 \times 810 \times 810 \times 12}{2 \times 32 \times 7000 \times 10}$ or 405 pounds and dividing this by the area of the bullet cross-section to bring it to pounds per square inch, we get 2550, the same as before. This tells us that besides getting the average pressure on the base of the bullet by using the velocity, as we did in the last chapter, we can get it by simply dividing the muzzle energy by the length of the barrel in feet.

As we have already explained, the energy varies directly as the weight of the bullet and the square of the velocity. To find the energy in foot pounds, multiply the square of the velocity in feet per second by one-half the mass of the bullet. The mass is the weight in grains divided by the acceleration of gravity, or 32.16. The formula is thus $E = \frac{mv^2}{2}$. Thus the bullet of the .45 automatic pistol, weighing 230 grains and moving 810 feet per second, would have $\frac{230 \times 810 \times 810.}{2 \times 7000 \times 32.16}$ or 336 foot pounds energy.

Energy Factor

It will be noted that in the formula the weight of the bullet is divided by 7000 to bring it from grains to pounds, and by the gravitational constant 32.16 to give mass, instead of weight, and that the factor one-half also enters. As these are the same for all calculations of energy, time and trouble can be saved by multiplying these quantities together ahead of time and noting the value for future reference. It is 450,240. Thus to obtain the energy of any bullet, multiply the square of the velocity by the bullet weight in grains, and divide by 450,240. This divisor is called the energy factor.

Penetration

In catalogs and ballistic tables, the penetration of bullets is generally given in pine boards ⅞ inches thick, spaced 1 inch apart. This gives a certain amount of information as to the relative power of the various bullets. It is not, however, a good index of killing power, for the relative effect of bullets on flesh depends largely on the shape of the point, and the boards are so hard that they make all points about the same.

Moreover, there are several other factors that enter in the case of boards. If the velocity is high, there is a certain amount of mashing of the whole bullet, which reduces the penetration, and makes the bullet seem poor, but a mashed bullet would give more rather than less effect on flesh.

Then there is the effect of stability. A very well balanced bullet that has plenty of stability will penetrate more than a badly balanced one that will turn over when it hits; but the poorly balanced one will have more stopping power than the other one.

The driving power that forces a bullet through a resistance is the energy; and the force that holds it back is the pressure on the nose of the bullet. The larger in diameter the bullet is, the more surface it has for the pressure to work against. We might expect, therefore, that a big bullet would have less penetration than a small one of the same energy.

Then also, something depends on the hardness, or resistance of the material. Obviously it would be harder to penetrate a board than to penetrate mud, and harder to penetrate steel than to penetrate boards.

We might expect, therefore, that the factor which reduces the penetration would be the resistance of the material in question multiplied by the area of cross section of the bullet. As the energy is what drives it through, and the resistance times the area of the bullet is what stops it, we might expect the penetration to be expressed by some such formula as $P = \frac{E}{RA}$. Where P represents penetration, E represents striking energy, and A represents the cross-sectional area of the bullet. As this is proportional to the square of the diameter of the bullet, we could also write it $P = \frac{E}{R d^2}$ where d represents the bullet diameter.

From experiments, it seems to the author that the resistance of pine boards can be approximately represented by 350 in this formula.

Using these assumptions, the probable penetration of the principal pistol cartridges was figured out by the formula, and the result compared with the known penetrations of the bullets in question, as obtained from tests. The calculated results and the actual ones show a remarkable agreement, which leads to the conclusion that the author's formula for penetration must necessarily be correct. The principal use of this formula is to figure out the probable penetration of bullets of different weight and velocity than the standard, as in the case of hand loads, etc.

A table of calculated and actual penetrations follows.

Table of Penetration

Penetration is given in ⅞″ pine boards, and is the average of several tests. "Penetration factor" or the measure of the ability of a bullet to overcome a uniform resistance is obtained by dividing the striking energy by the cross sectional area of the bullet in square inches. From this figure the actual approximate penetration is obtained by dividing by a number that depends on the resistance of the material to be penetrated. For pine boards this number is found by the author to be somewhere in the neighborhood of 350. Naturally this can give only an approximation, as the actual penetration will depend on several things, such as the relative hardness of the wood, whether it is damp or well dried, whether the bullet is jacketed or not, how much the bullet deforms on impact, etc. A badly balanced bullet may turn over on impact, and the penetration will be poor, as in the case of the .32-20.

Name of Cartridge	*Velocity f.s.*	*Energy ft. lbs.*	*Bullet area, sq. ins.*	*Penetration factor*	*Calculated penetration ⅞″ boards*	*Actual penetration ⅞″ boards*
.30 Caliber Mauser	1323	329	.075	4390	12.5	11
.38/44 S. & W. Spl.	1100	425	.102	4170	11.8	11
Super .38 A.C.P.	1200	417	.102	4080	11.6	11
.30 Caliber Luger	1180	290	.075	3865	11.0	10
9 MM Luger	1075	320	.098	3260	9.3	9
.32-20	954	232	.076	2900	8.2	6
.38-40	950	360	.126	2859	8.1	7
.45 Colt, Western	910	460	.163	2825	8.0	8
.44-40	918	375	.143	2620	7.5	7
.38 Special	860	260	.102	2548	7.3	7
.38 Special Super Police	725	246	.102	2420	6.9	5
.44 S. & W. Special	770	320	.146	2260	6.5	7
.38 Long Colt	810	230	.102	2250	6.4	7
.44 Russian	750	316	.146	2160	6.1	7
.45 Automatic Gov't	810	340	.159	2140	6.1	7
.45 Colt	770	320	.163	2023	5.7	5
.22 Long Rifle, Outdoor	930	77	.039	1975	5.6	5
.32 A. C. P.	950	140	.076	1840	5.2	5
.41 Long Colt	720	220	.129	1705	4.9	5
.38 S. & W.	730	170	.102	1675	4.8	5
.38 Colt New Police	710	170	.102	1675	4.8	5
.380 A. C. P.	900	170	.102	1670	4.8	5
.38 S. & W. Super Police	610	166	.102	1630	4.6	4

Name of Cartridge	*Velocity f.s.*	*Energy ft. lbs.*	*Bullet area, sq. ins.*	*Penetration factor*	*Calculated penetration ⅞" boards*	*Actual penetration ⅞" boards*
.32 S. & W. Long	750	124	.076	1630	4.6	4½
.32 Colt New Police	730	118	.076	1550	4.4	4
.32 S. & W.	725	99	.076	1305	3.7	3½
.22 Long Rifle	750	50	.039	1280	3.6	3½
.25 A. C. P.	745	62	.049	1265	3.5	3

Ballistic Tables

In this book are included several tables giving the ballistics of American and foreign pistol cartridges, and other exterior ballistic data of interest. In referring to these tables it should be borne in mind that there are numerous differences between the cartridges of the same caliber produced by different manufacturers. For this reason a ballistic table cannot be exact without going into great detail and listing every manufacturer separately. For example, take the case of bullet weights. The standard bullet weight for the .45 Colt is usually given as 255 grains, but some makers use a 250-grain bullet. Again, some makers use a different weight bullet in a given caliber for a smokeless load from the weight used for a black-powder load. Then some makers may test a cartridge, such as the .22 Long rifle, in a 10-inch single-shot pistol, while another maker may test the same cartridge in a revolver with a 6-inch barrel. It is quite obvious that the results would be different.

Another very important thing is that some makers load their black and smokeless powder cartridges to the same ballistics, while other makers load their black-powder cartridges to a higher velocity than their smokeless-powder cartridges. In other words, they consider it more desirable to crowd each individual type of a given caliber to the limit in velocity consistent with safety than to have the velocity uniform for the different kinds. For these reasons any ballistic table must be more or less of a compromise based on consideration of the various results obtained with cartridges of different manufacture.

CHAPTER 10

DETAILED INDIVIDUAL DESCRIPTION OF PISTOL AND REVOLVER CARTRIDGES

IT has been the aim of the author in compiling this chapter to gather together into one place as much detailed data and information as possible concerning each cartridge that the pistol or revolver shooter or the legal firearms expert is likely to encounter. It has been manifestly impossible to cover every make of every pistol or revolver cartridge in the world, but a sample of a representative make of every common American pistol cartridge has been carefully weighed, measured, and tested, and the results recorded here. In general, the lengths, diameters, etc., given are the results of actual measurements by the author of a number of samples of each cartridge. In using these measurements, the reader should bear in mind that there may be slight variations between different makes, and even between different samples of the same make; the aim has been to give a good average figure.

Factories do not like to make public the exact bullet diameter used, the exact charge of smokeless powder, or the pressure. However the author has endeavored to set down these figures for a representative factory load for each cartridge discussed, but in deference to the wishes of the makers, the name of the factory is omitted. Some time one make is used in the example quoted, sometimes the product of another manufacturer. Factory names are, however, quoted in connection with ballistics, that is bullet weight and muzzle velocity, as these figures are published by each factory. In many types of cartridge, the large American factories will all use the same bullet weight and load to the same velocity; but in other cases there will be slight differences in velocity, bullet weight, or both. Where all makers use the same standards, just one velocity and bullet weight is given in the tabulations; but where there are marked differences in the standards used in one or more makers, separate figures are given for the makes concerned.

In many cases, recommended charges for hand loading are included. These have all been obtained from sources believed to be reliable, and the greatest care has been used in compiling them, so that they are believed to be perfectly safe to use under properly controlled conditions; but arms vary so in condition, and individuals differ so much in the skill and intelligence with which the reloading is performed, that neither the author nor the publisher can be responsible for any failure for these loads to work as expected, and all information of any kind included in this book is for the reader to use in any way that he may see fit at his own risk.

Cartridges described are listed by caliber, starting with the smallest first, so that the diameter of the bullet may serve as an index.

.22 CALIBER CARTRIDGES

There are no less than eight distinct types of .22 caliber rim-fire cartridges made in this country, of which six are regularly used in pistols and revolvers. There are also several center fire .22 caliber cartridges made, such as the .22 Winchester Center Fire, the .22 Hornet, and the .22 Savage High Power. As no revolvers are regularly made for the .22 Automatic Rim Fire, the .22 Remington Autoloading, or the .22 center fire cartridges, no detailed description of them will be given.

.22 B.B. Cap. (Bullet Breech Cap)

This is the smallest cartridge made or used in this country. It is a very short rim fire .22 caliber cartridge, with a lead bullet weighing only 20 grains. The cartridge case is made of copper, and is the same diameter as the .22 short and the other .22 rim fire cartridges, but is much shorter.

These cartridges were originally intended for use in Flobert Rifles, but they are found to be very accurate in revolvers and single shot pistols, and as they have very low power, and make scarcely any noise at all, they are very useful for indoor shooting. With an X-Ring Bullet Trap and a supply of B. B. Caps, the ordinary cellar makes a very satisfactory shooting gallery where much valuable and entertaining target practice may be had.

The bullet for the B. B. Cap is about as long as it is wide, and has a conical point with a rather abrupt shoulder where it joins the cylinder. This makes it tend to cut a clean hole in the paper, like the hole made by a wad-cutter.

The B. B. Caps may be obtained with copper clad, cadmium plated, or lubricated bullets. The lubricated type is slightly more messy to handle, but is less likely to lead the gun, though there is not so very much danger of leading unless a lot of shooting is done very rapidly.

Diameter of bullet	.224 inch
Weight of bullet	20 grains
Length of bullet	.25 inch
Diameter of case at head	.279 inch
“ “ “ “ mouth	.228 “
Length of case	.28 inch
Length of cartridge overall	.42 “
Muzzle velocity, rifle	875 feet per second (Federal Ctg. Co.)
“ energy “	34 foot pounds
Muzzle velocity, 6 inch revolver	750 feet per second (Remington)
“ energy, revolver	25 foot pounds

.22 C. B. Cap (Conical Ball Cap)

This cartridge has a case of the same size as that for the B. B. Cap, loaded with a larger bullet, which is the same as the bullet for the .22 Short cartridge. Like the B. B. cap, it makes very little noise, and is good for indoor practice. However I do not like it quite as well for this purpose as I do the B. B. Cap, for it is no more accurate, and has more power and more noise, both of which are undesirable for a cellar range. Moreover, it does not cut a sharp hole as does the B. B.

Bullet diameter	.224 inch
Bullet weight	29 grains
Bullet length	.36
Cartridge case dimensions	Same as for B. B. Cap.
Length of cartridge overall	.55 inch
Muzzle velocity, rifle	975 f. s. (Federal Ctg. Co.)
Muzzle energy, rifle	61 foot pounds.
Muzzle velocity, 6 inch revolver	780 foot seconds (Remington)
Muzzle energy, revolver	39 foot pounds.

.22 Short, Rim Fire

This cartridge, one of the most popular in the world, was designed by Smith & Wesson in 1854, and today, 80 years later, is used in almost the same form as it was then. It has a 29 or 30 grain bullet, with a diameter of .223 to .224, some makers using 29 grain bullets as standard, while others prefer the 30 grain weight. It is loaded with black, smokeless, or Lesmoke powder. The standard charge of black powder is 3 grains, and of smokeless about ¾ of a grain.

Previously the .22 short smokeless loads were very destructive to gun barrels because the powder charge was so small that the corrosive residue of the primer was not sufficiently diluted; but since the advent of the noncorrosive primer, the smokeless loads have largely superseded the others, and are recommended in preference to either the black or the Lesmoke.

This cartridge is extremely accurate, and is very useful for rifle work, but is not much used in revolvers and pistols because most target revolvers and pistols are built, at the present time, with special reference to the use of the Long Rifle cartridge. The .22 Short can be used in any gun that is chambered for the .22 Long Rifle. The twist required for the .22 Short is not quite as great as that required for the .22 Long Rifle because the shorter bullet is easier to stabilize.

In using a .22 short in a barrel chambered for the .22 Long Rifle, or in a cylinder chambered for a long-rifle cartridge, a roughness or burning of the metal just forward of the place where the mouth of the short cartridge comes will eventually take place. This does not harm the accuracy of the gun when it is used with the longer cartridge, because this rough or corroded spot is covered up by the neck of the cartridge, but the result is that it makes the long rifle cartridge harder to extract.

The .22 short is made in several different styles. The ordinary .22 short smokeless with the lubricated lead bullet, giving a muzzle velocity in rifles of about 925 to 950 feet per second, according to make, may be considered as standard. In addition, all the companies make a hollow point cartridge, with a cavity in the point, and a bullet 2 grains lighter than the solid ball. The hollow point gives greater game killing ability. Then in addition, all companies now make a high speed type of .22 short, under some such name as Hi-Speed, High Velocity, Super X, etc. This is made with both the solid and the hollow point bullets.

Then in order to cater to the desires of those marksmen who desire to carry the cartridges loose in the pocket, there are greaseless or unlubricated cartridges made by all the companies. An example of a trade name covering the dry type is the Remington "Silvadry" cartridge with a cadmium plated bullet. Many companies plate all their .22 bullets with copper or lubaloy, which probably has a tendency to reduce the tendency to leading, but will not take the place of adequate lubrication.

For gallery use there is a special lead bullet made of compressed lead dust to prevent the danger from particles of the bullet bouncing back from the iron target plates, which is called spatter back. When these bullets of compressed lead dust hit the iron plate they simply go to powder, so that there are no particles left to fly back. Each company has its own trade name, of which examples are "Spatterproof," "Spatterless," "Krumble Ball," etc.

Bullet diameter	.223 inch or .224 inch
Bullet weight	29 grains or 30 grains
Length of bullet	.36 inch
Diameter of case at head	.279 inch
" " " " mouth	.228 "
Length of case	.42 inch
Length of cartridge overall	.69 "
Factory Black Powder charge	2.6 grains FFFG
Velocity, 6 inch revolver	755 foot seconds
Factory Lesmok Load	1.7 Grains Lesmok A.
Pressure	10,000 pounds
Velocity, 6 inch revolver	755 foot seconds
Factory Smokeless load	.82 grains DuPont No. 92
Pressure	10,000 pounds per square inch
Velocity, 6 inch revolver	750 foot seconds
Penetration, ⅞ inch pine boards	2 boards
Name, Winchester	.22 short, staynless
Muzzle velocity, rifles	975 foot seconds
" energy, rifles	63 foot pounds
" velocity, 6 inch revolver	850 foot pounds
" energy, revolver	48 foot pounds
Name, Western Ctg. Co.'s	.22 short Super X
Powder charge	1.49 grains smokeless
Muzzle velocity, rifles	975 foot seconds
" energy, "	63 foot pounds
Muzzle velocity, 6 inch revolver	850 foot pounds
" energy "	48 foot pounds

.22 Long, Rim Fire

This is a mongrel cartridge, having the bullet of the .22 short and the cartridge case and powder charge of the .22 long rifle. It is not as accurate as either the short or the long rifle, and has nothing to recommend it. Like the short, it is made in the hollow point, dry, etc., as well as in the regular type.

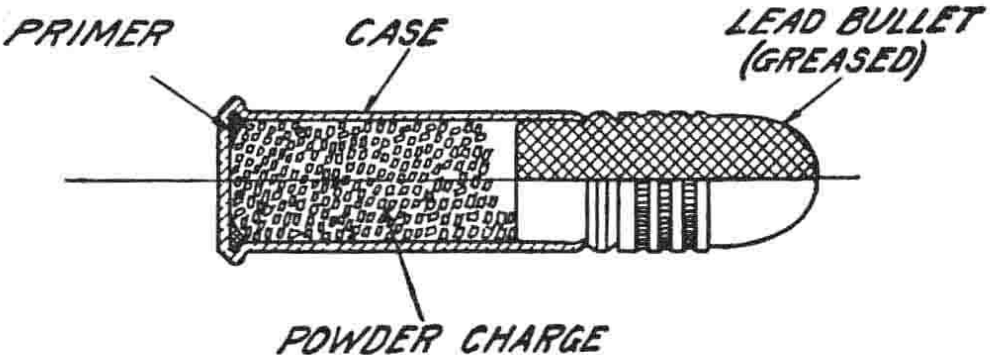
Bullet weight	29 grains or 30 grains
Bullet diameter	.224 inch
Velocity in rifle	975 feet per second
Muzzle energy	63 foot pounds
Muzzle velocity, 6 in. revolver	870 foot seconds
Muzzle energy, revolver	50 foot pounds

.22 Caliber Long Rifle

This is one of the most accurate cartridges in the world and is the favorite with target shots. There are more .22-caliber Long Rifle cartridges sold than all other kinds for use in pistols and revolvers. The .22 Long Rifle cartridge has a 40-grain bullet with a diameter of from .223 to .226, depending on the make.

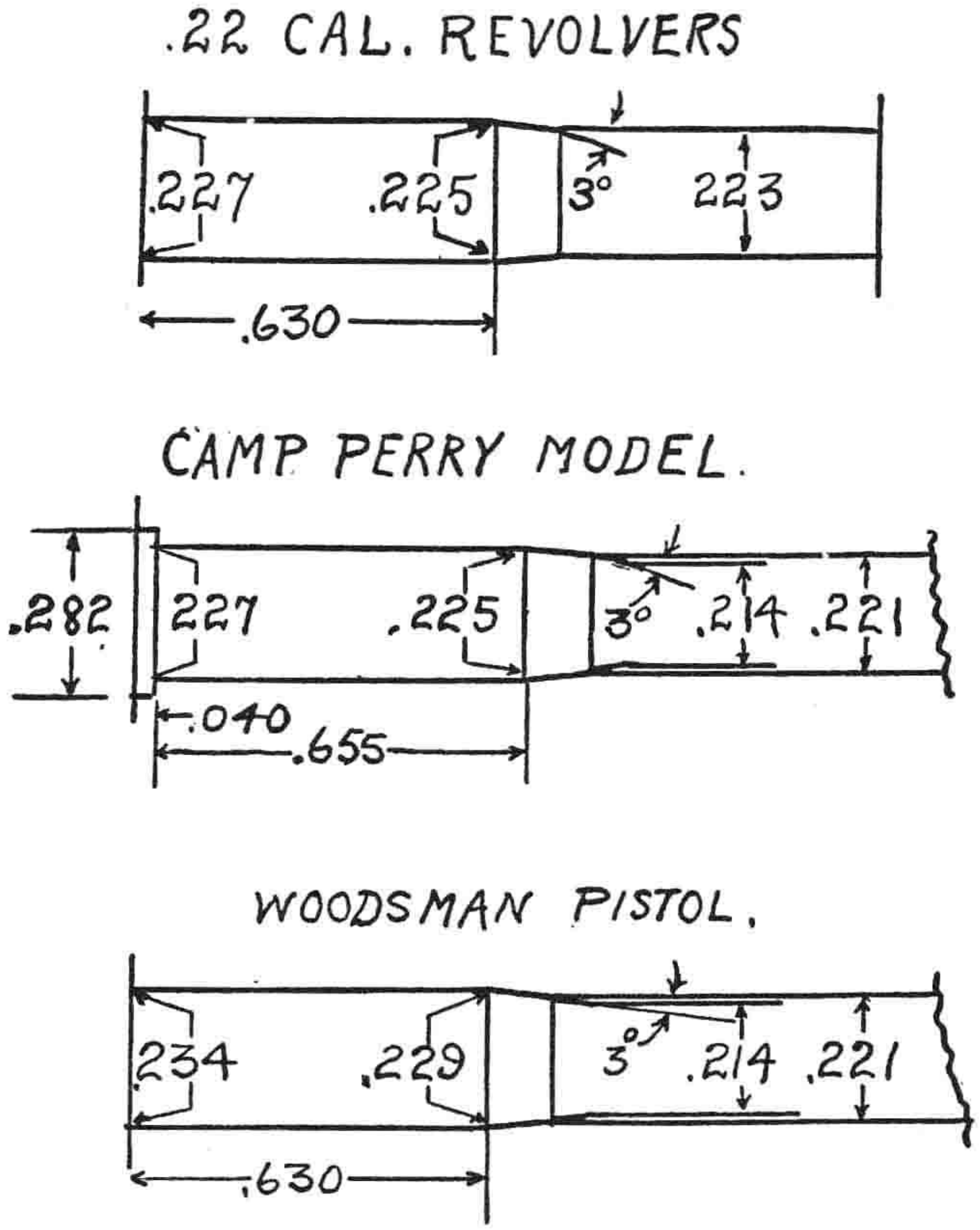
The cartridge case, made of copper or brass, is almost exactly like that of the .22 short, except that it is slightly longer so as to hold an increased powder charge.

For many years the .22 long rifle cartridge was loaded to a standard velocity of about 950 feet per second; but finally a so-called outdoor type was developed, with about from 1050 to 1100 foot seconds velocity. This cartridge was loaded with Lesmoke, the first of its kind being the United States Cartridge Company's N. R. A. cartridge. Other brands are Western Marksman, Remington Palma, Peter's Tackhole, and Winchester Precision. The next innovation was the production in 1929 of a Hi-Speed Cartridge by Remington, with a velocity nearly two hundred feet higher than any other .22 cartridge then on the market, or about 1275 feet per second. Western Cartridge Company in the latter part of 1930 produced a new line of ultra high speed .22 caliber cartridges known under the trade name of Super-X. The Super-X cartridges were claimed to have 1400 feet per seconds in the rifle, but samples received by me from the factory in December 1930 actually gave 1417 feet per second when tested. These cartridges were found to be loaded with 2.5 grains of smokeless powder, determined by breaking down and weighing a number of samples. At the present time all companies make high velocity .22 caliber long rifle cartridges.



CAL. .22 LONG RIFLE CARTRIDGE.

For many years the .22 caliber outdoor type loaded with Lesmoke powder to give 1100 feet per second in rifles, and about 950 feet per second in revolvers or pistols was the standard load for target use; but in the last few years all the cartridge companies have developed satisfactory non-corrosive primers, so that the smokeless loads are now superseding the Lesmoke type. Names of popular smokeless target loads are: Remington Kleanbore, Winchester Staynless, Peter's Rustless, Western Super-Match.


.22 CAL. REVOLVERS
.227
.225
3°
.223
.630
CAMP PERRY MODEL.
.282
.227
.225
3°
.214
.221
.040
.655
WOODSMAN PISTOL.
.234
.229
3°
.214
.221
.630

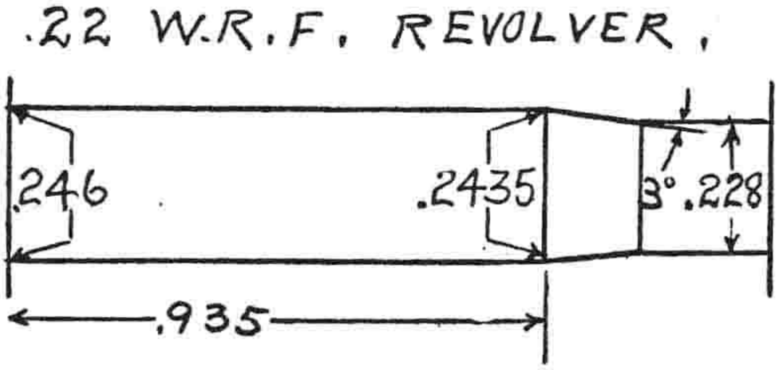
STANDARD CHAMBER DIMENSIONS OF COLT PISTOLS AND REVOLVERS
The upper chamber, accommodating .22 BB Caps, .22 C. B. Caps, .22 Short, .22 Long, and .22 Long Rifle Cartridges, is used in the Police Positive Target, the Official Police, and the Officer's Model Revolvers.

Name	.22 Long Rifle Rim Fire
Length overall	.995 inch
Length case	.613 inch
Bullet weight	40 grains
Bullet weight, Hollow point	37 grains
Charge, Smokeless powder	1.35 Dupont No. 93
Charge, Black powder	3.5 grains FFFG
Charge, Lesmok powder	2.5 Lesmok A
Pressure, smokeless load	11,000 lbs. per square inch
Muzzle velocity, rifle	950 foot seconds
Muzzle velocity, 6 inch barrel	750 foot seconds
Muzzle energy	50 foot lbs.
Penetration, ⅞ inch boards	3 boards
Name	.22 l. r. outdoor type
Powder charge	3 grains Lesmok A
Pressure	15,000 lbs. per square inch

Velocity, rifle	1100 foot seconds
Velocity at 100 yds. rifle	930 foot seconds
Muzzle energy, rifle	117 foot pounds
Muzzle velocity, 6 inch barrel	940 foot seconds
Muzzle energy, 6 inch barrel	78 foot lbs.
Penetration ⅞ inch boards	3 boards
Name	.22 Remington Kleanbore
Muzzle velocity, rifles	1070 foot seconds
Muzzle velocity, 6 inch barrel revolver	900 foot seconds
Name	.22 Hi-Speed Kleanbore
Velocity, rifles	1275 foot seconds
Velocity, 6 inch barrel revolver	1100 foot seconds
Muzzle energy	107 foot pounds
Name	.22 Super Match
Muzzle velocity, rifles	1215 foot seconds
Muzzle velocity, 6 inch barrel revolver	1015 foot seconds
Name	.22 Super-X Long Rifle
Powder charge	2.5 grains smokeless
Muzzle velocity, rifles	1400 foot seconds
Muzzle velocity, 6 inch barrel revolver	1075 foot seconds
Muzzle energy, revolver	102 foot pounds

.22 W.R.F. (Winchester Rim Fire)

This is a .22 caliber rim fire cartridge that is somewhat larger than the .22 long rifle. The old standard load for the long rifle cartridge was a 40 grain bullet and five grains of black powder, whereas the .22 W. R. F. has a 45 grain bullet and used to have seven grains of black powder, from which it is often called the .22-7-45.



The Colt Police Positive Target revolver can be obtained in this caliber, which formerly was more powerful than the .22 long rifle; and like it, is made in the high speed as well as the regular type.

Name	.22 Winchester Rim fire, Staynless
Bullet weight	45 grains
Bullet diameter	.228
Muzzle velocity, rifles	1010 foot seconds
Muzzle velocity, 6 inch revolvers	810 foot seconds
Muzzle energy, 6 inch revolver	66 foot pounds

Name	.22 W. R. F. Super-X
Muzzle velocity, rifles	1445 foot seconds
Name	.22 W. R. F. Kleanbore Hi-Speed
Muzzle velocity in rifles	1500 foot seconds

5.5 m/m Velo Dog

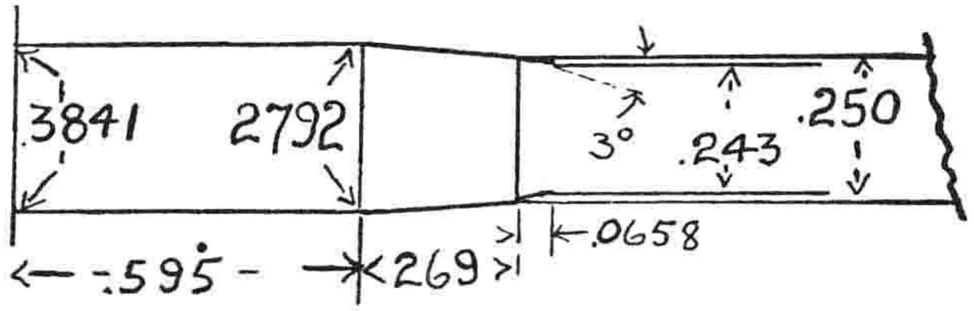
This is a very long cartridge of .22 caliber with a metal jacketed bullet weighing 45 grains. The cartridge is only adapted to a foreign gun called the Velo Dog, which is a high velocity Bull Dog type of revolver not often seen in America.

Name	5.5 m/m Velo Dog
Bullet weight	45 grains
Bullet length	.48 inch
Case length	1.12 "
Length loaded cartridge	1.35 "
Diameter of rim	.308 "
Thickness of rim	.047 "
Diameter case, rear,	.253 "
" " front,	.248 "
Muzzle velocity, 2 inch barrel	760 f. s.
Muzzle energy	56 ft. lbs.

.25 Caliber (6.35 m/m) Automatic Colt Pistol

This was first made for the Browning automatic pistol under the name of the 6.35 mm. and was primarily a European cartridge, but was afterwards introduced into this country extensively when the Colt Patent Fire Arms Company took up the manufacture of the .25-caliber automatic. It is a very powerful cartridge for its size, having a 50-grain bullet with a velocity of 758 foot-seconds. It looks like a rimless cartridge, but is of the semi-rim type.

.25 AUTO.



Overall length of cartridge	.905
Bullet weight	50 grains
Type of bullet used	Metal jacketed
Seating depth of bullet	.15 inch
Bullet diameter	,251
Bullet length	.46 inch
Diameter cartridge head	.298 "
" " mouth	.276 "

Length cartridge case	.62 "
Length loaded cartridge	.91 "
Type of cartridge	Semi-rim
Factory charge	1.65 grains Infallible
Pressure	10,000 lbs. per square inch
Velocity in 2 inch pistol	758 foot seconds
Energy	67 foot pounds
Penetration, ⅞ inch pine boards	3 boards
Charge for reloading	1.4 gr. Bullseye Powder
Velocity	751 foot seconds
Pressure	12,930 lbs. per square inch
Recommended by	Hercules Powder Co.
Charge for reloading	1.4 grains DuPont No. 5
Velocity	758 foot seconds
Pressure	15,000 lbs.
Recommended by	DuPont Powder Co.

6.5 mm. Bergmann Automatic

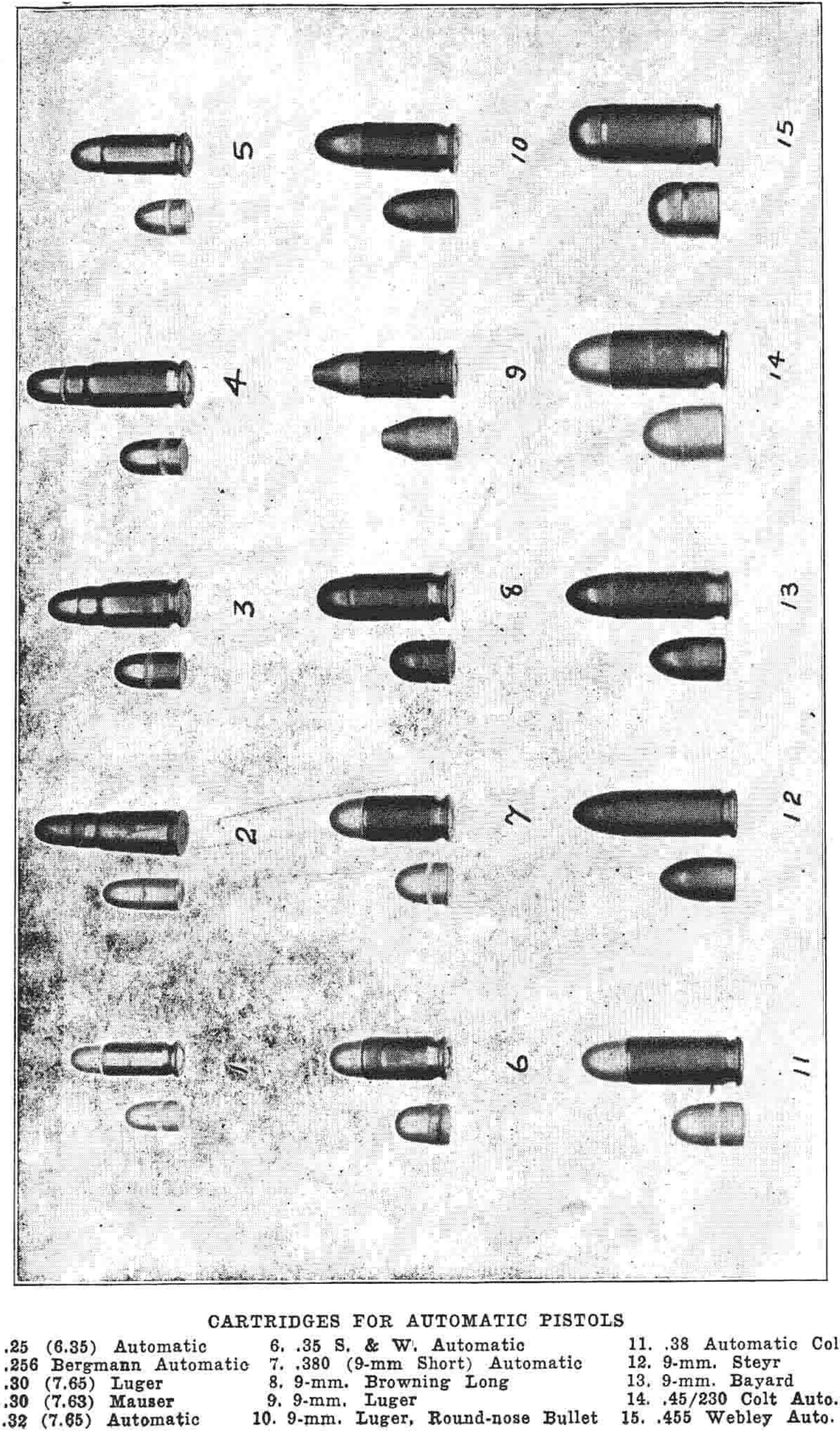
This is a very high powered, .26 caliber automatic with a rimless, bottle necked cartridge which looks something like the .30 caliber Luger cartridge. It contains a 76 grain, metal jacketed bullet with 2.2 grains of very fast burning smokeless powder.

Bullet weight	76 grains
Bullet diameter	.264 inch
Bullet length	.64 "
Diameter of cartridge head	.373 "
Diameter of cartridge body, rear	.367 "
Diameter of cartridge body, front	.324 "
Diameter of Cartridge Neck	.289 "
Length of case	.87 "
Length of Cartridge	1.23 "

7.5 mm. Nagant

The Nagant revolver used by the Russian, Norwegian, and other armies has a very distinctive action. The front part of each chamber in the cylinder is tapered and the rear end of the barrel is tapered to fit into this chamber. When the gun is cocked the cylinder is pushed forward so that the back end of the barrel enters the front part of the chamber, thus forming a seal to prevent the escape of gas between the barrel and the cylinder. In order to seal this gap more effectively the cartridge case is made longer than the bullet—that is, the bullet is sealed entirely inside the cartridge, and the front end of the cartridge case enters the barrel itself when the cylinder is pushed forward. The front end of the brass cartridge is tapered in toward the point of the bullet so as to facilitate its entering the barrel.

The Nagant cartridge shown in the photograph is loaded, but in the picture it looks like an empty case because the bullet is entirely



CARTRIDGES FOR AUTOMATIC PISTOLS

1. .25 (6.35) Automatic
2. .256 Bergmann Automatic
3. .30 (7.65) Luger
4. .30 (7.63) Mauser
5. .32 (7.65) Automatic
6. .35 S. & W. Automatic
7. .380 (9-mm Short) Automatic
8. 9-mm. Browning Long
9. 9-mm. Luger
10. 9-mm. Luger, Round-nose Bullet
11. .38 Automatic Colt
12. 9-mm. Steyr
13. 9-mm. Bayard
14. .45/230 Colt Auto.
15. .455 Webley Auto.

inside the cartridge case and does not project out where it can be seen.

This cartridge is too small in caliber and too low in velocity to have much stopping power or effectiveness.

Bullet weight	108 grains
Bullet diameter	2.95 inches
Diameter cartridge head	.388 "
Diameter cartridge body, rear	.355 "
Diameter cartridge over bullet	.330 "
Diameter cartridge case, front	.285 "
Length of cartridge case	1.53 "
Length of loaded cartridge	1.53 "
Powder charge, lead bullet	10 Grains black
Powder charge, M. C. bullet	5 " Smokeless
Velocity	725 f. s.
Energy	122 ft. lbs.

.30 (7.63 m/m) Mauser Automatic Pistol Cartridge

This is a rimless high-velocity, high-pressure cartridge. It has the highest velocity of any pistol cartridge, and the pressure runs up to around 30,000 pounds, over twice that of the ordinary revolver cartridge. It has an 85-grain bullet, and the velocity varies with different makes, from about 1,200 to about 1,325 foot-seconds. This is a European cartridge, and the foreign name of it is the 7.63-mm. Mauser.

The Mauser Company also makes a .32 pocket pistol, and that is called the 7.65-mm. The name is almost the same, but there is a big difference in the two cartridges. The .30-caliber Mauser cartridges are made either full metal-jacketed or soft point.

Bullet weight	85 grains
Bullet diameter	.309 inch
Bullet type	Metal cased or soft point
Length of bullet	.54 inch
Diameter cartridge head	.390 "
" " mouth	.332 "
Length cartridge case	1.04 "
Overall length of loaded cartridge	1.35 inch
Representative factory charge	7.0 grains Ballistite
Pressure	29,000 lbs.
Muzzle velocity, 5½ inch barrel	1323 feet per second
Muzzle energy	329 foot pounds
Penetration, ⅞ inch pine boards	11 boards
Remington velocity	1280 feet per second
Winchester velocity	1397 foot seconds
Western velocity	1323 feet per second

.30 Caliber (7.65 m/m) Luger

This is another rimless high-velocity pistol cartridge, but not as high as the Mauser. It has a velocity of around 1,200 foot-seconds, and the pressure is about 21,000 pounds. It has a 93-grain bullet made either soft point or full metal-jacketed. The name of this cartridge does not follow the same rule as that of the Mauser, because this is called 7.65-mm. Luger, whereas the Mauser is called 7.63, though the bullets are the same diameter, namely, .309. This bullet has great penetration, but not much shocking power because it is too small in caliber.

This 7.65 cartridge should not be confused with the other European 7.65's, which are the same as the .32 Automatic Colt.

Special cartridges are made by foreign makers for the Luger Carbine, which takes a more powerful cartridge to operate the heavier springs. The carbine cartridge is loaded with more pressure, and hence a higher velocity than the pistol cartridge, and is marked by being colored black. It gives a velocity in the 4½-inch barrel of 1363 against 1200 for the regular cartridge. The call for them is so small that they are not made in this country. The carbine may be used with satisfaction for single shots with the regular cartridges, which may even operate the mechanism at times.

The following ballistic data for the .30 Luger Pistol given in a German catalog may be of interest:

Distance	*Group height*	*Group width*	*Height of 100 meter trajectory*	*Height of 200 meter trajectory*
25 meters	2.4 inches	1.2 inches	5.9 inches	
50 "	4.3 "	2.7 "	9.4 "	17.3 inches
60 "			9.85 "	
75 "	7.1 "	4.7 "	8.3 "	
100 "	10. "	7.1 "		23.6 "
125 "				25.5 "
150 "	17.7 "	13. "		21.3 "

Name	.30 Caliber (7.65 mm) Luger
Make	German
Bullet weight	92.6 grains
Bullet diameter	.309
Bullet type	Full jacketed or soft point
Jacket material	Cupro-nickel coated steel
Bullet length	.58 inch
Diameter cartridge head	.390 "
" " mouth	.332 "
Length cartridge case	.85 inch
Length loaded cartridge	1.14 "
Powder charge	5.09 grains Rottweil flake
Pressure	28,798 lbs. per square inch
Velocity	1150 foot seconds
Name	.30 Caliber Luger
Make	American
Powder charge	4.7 grains Infallible

Velocity in 3¾ inch barrel	1207
Energy	300 foot pounds
Penetration, ⅞ inch pine boards	10 boards
Velocity, Remington make	1180. f. s.
Velocity, Peters make	1173 f. s.
Velocity, Western make	1173 f. s.
Velocity, Winchester make	1225 f. s.

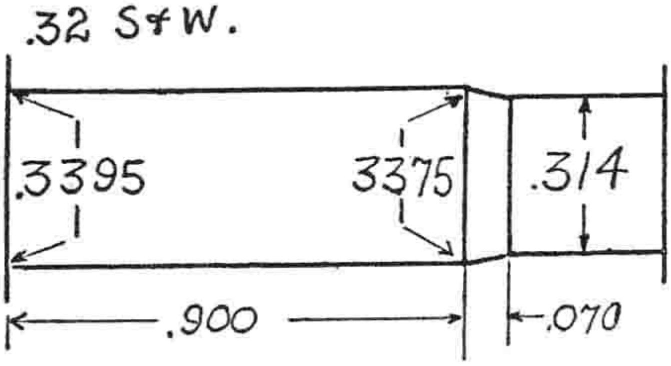
.32 Rim Fire Cartridges

There are a great many old .32 rim fire revolvers still in existence, but the cartridges have long ago become obsolete, so that they can be found today only in the very large stores. These cartridges are of the same general construction as the .22 caliber rim fire cartridges, but are made larger. They have lead bullets, outside lubricated.

The .32 extra short has a 55 grain bullet. The .32 short has an 80 grain bullet and is loaded with 9 grains of black powder. The .32 long has a 90 grain bullet with 13 grains of black powder.

.32 Smith & Wesson

This is a standard size cartridge for small pocket revolvers. It was originally made with an 85-grain lead bullet and 9 grains of black powder. It is now loaded with either black or smokeless powder, the average velocity being around 632 foot-seconds, though some makers load to higher velocities. It is a small, low-powered cartridge with little noise and practically no recoil, but capable of killing at short ranges. On account of the low velocity and small weight of the bullet, the stopping power is inferior.



This chamber will accommodate the .32 S. & W., the .32 S. & W. Long, and the .32 Colt New Police cartridges, and is used in the Pocket Positive, Police Positive, and Police Positive Target revolvers.

Bullet weight	85 and 88 grains
Bullet diameter	.314
Bullet length	.54 inch
Diameter of cartridge head	.374 "
" " " mouth	.336 "
Length of case	.60 "
Length loaded cartridge	.92 "
Representative factory charge	1.4 grains Bullseye

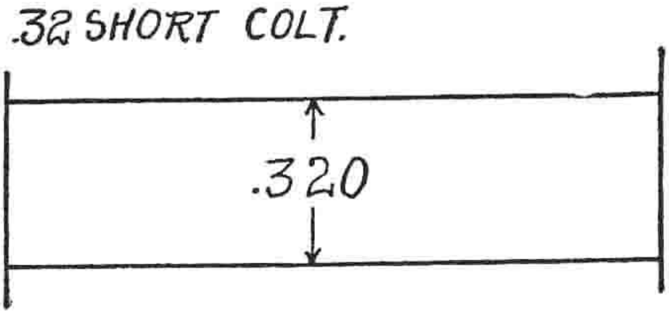
Pressure	8,000 pounds per square inch
Velocity	725 feet per second
Energy	99 foot pounds
Penetration ⅞ inch pine boards	3½ boards

There is some variation in the standards used by the different companies as follows:

Make	*Bullet weight*	*Velocity*
Peters	85 grains	635 foot seconds
Remington	88 "	710 " "
Western	85 "	725 " "
Winchester	85 "	700 " "

.32 Short Colt. .320 Revolver

These are old cartridges, designed years ago for arms that are now obsolete. The .32 short Colt was originally used in Colt revolvers, while the .320 Revolver Cartridge was a foreign cartridge made to fit the Webley, Tranter, and other European revolvers of this size. The .32 Short Colt will fit the revolvers chambered for the .320, and the .320 can be used in the Colt revolvers of .32 Short caliber, so that these cartridges may be used interchangeably.



This chamber is now obsolete, and is no longer made. It is found in the following arms which have been chambered for the .32 Short Colt cartridge: Pocket Positive, Police Positive, Police Positive Target, Single Action Army, Bisley Model, and Bisley Model Target.

They are black powder cartridges, with outside lubricated lead bullets. The .32 Short Colt is loaded with black or smokeless powder; the .320 with black powder only. While these cartridges resemble the .32 Smith & Wesson, they will not interchange with it, as there are some differences in dimensions, as will be seen from an examination of the tabulated data.

Bullet diameter	.313 inch
Bullet weight	82 grains
Bullet length	.48 inch
Diameter cartridge head	.315 "
" mouth	.375 "
Length of case	.64 "
Length loaded cartridge	1.05 "

Factory charge, black powder	7.7 grains FFFG
" " smokeless powder	1.9 grains Bullseye
Pressure	8,000 lbs. per square inch
Velocity in 6 inch revolver	810 f. s.
Energy	116 foot pounds
Penetration, ⅞ inch pine boards	4 boards

For reloading, use an 82 grain lead bullet and 7 grains of King's Semi-smokeless FFG.

.32 Long Colt

Like the .32 short Colt, this is an obsolete cartridge, now made only to take care of the occasional demand from the owners of old guns of this caliber that are still in existence. The .32 Short Colt originally had an 80 grain outside lubricated bullet, and was loaded with 9 grains of black powder, while the .32 Long Colt had a 90 grain outside lubricated bullet and 12 grains of black powder. The diameter of the body of the bullet was .313, and the outside diameter of the case was the same; the bullet had a "heel" of reduced diameter, (.299 inch) to fit inside of the case. When the inside lubricated bullets of the same diameter both inside and outside the case came into use, the .32 S. & W. cartridge was produced, with a bullet the same in maximum diameter as the .32 short and long Colt, and with a cartridge case big enough to fit over the bullet of this diameter instead of fitting over a reduced diameter heel.

Thus the case of the .32 Long Colt is only .313 in diameter, while that of the .32 S. & W. is .336 in outside diameter. This explains why the two cartridges, which look much alike, will not interchange.

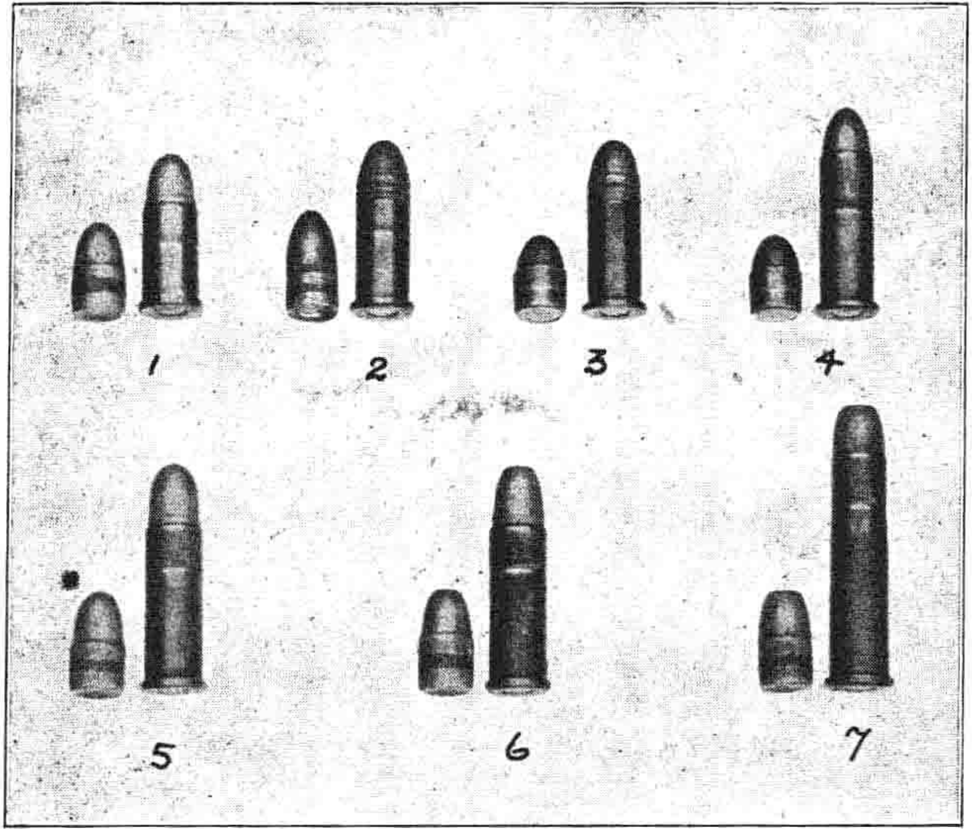
Lately the .32 Long Colt has been changed to inside lubrication. The bullet is made the same diameter outside of the case as inside, namely, .299, which is too small to fit the rifling, but a very deep hollow base is provided, so that the powder pressure will swell out the base to fit the rifling. This change reduced the weight of the bullet to 82 grains, which is now the standard.

Bullet weight	80 grains
Bullet diameter	.299 inch
Bullet length	.62 "
Diameter cartridge head	.374 "
Diameter cartridge body outside	.313 "
Length of case	.92 "
Length loaded cartridge	1.26 "
Typical factory charge	2.1 grains Bullseye
Pressure	8,000 pounds
Velocity, 4 inch barrel	770 f. s.

Energy	110 ft. lbs.
Penetration, ⅞ inch pine boards	4 boards

Reloading Data

Bullet name	Ideal 299155	Ideal 299155	Ideal 299155
Bullet weight	80 grains	80 grains	80 grains
Powder, kind	Pistol No. 5	S. R. No. 80	Bullseye
Powder, charge	3.1 grains	6.5 grains	2.0 grains
Velocity	830 f. s.	815 f. s.	765 f. s.
Recommended by	Ideal handbook	Ideal handbook	Ideal handbook



.32-CALIBER REVOLVER CARTRIDGES

1. .32 S. & W.
2. .32 Short Colt
3. .320 Revolver (Black Powder)
4. .32 Long Colt
5. .32 S. & W. Long
6. .32 Colt New Police
7. .32 Winchester (.32/20)

.32 Smith & Wesson Long

.32 Colt New Police (Police Positive)

These are more powerful cartridges for the small pocket size revolvers than was the original .32 Smith & Wesson. These two cartridges are interchangeable. The .32 Smith & Wesson Long has a 98-grain bullet, and the original black powder charge was 13 grains. The smokeless load is around 2 grains of Bull's-Eye. The velocity is 790 foot-seconds and the energy 140 foot-pounds. It is a very highly accurate cartridge.

The .32 Colt New Police, now known as the "Colt Police Positive," is an advanced design of .32-caliber cartridge, which is interchangeable with the .32 Smith & Wesson Long. It has a 100-

grain bullet with about 730 foot-seconds velocity and 120 foot-pounds of energy. The Colt New Police Cartridge differs from the Smith & Wesson Long mainly in that it has a flat point which gives it superior stopping power. A mid-range load is made for this cartridge with a 100-grain bullet and a reduced velocity.

All Colt and Smith & Wesson pistols and pocket arms in .32 caliber are now chambered for the .32 Smith & Wesson Long, and the .32 Colt Police Positive can be used in the same gun. An exception is the Smith & Wesson .32 Safety Hammerless, which is made only for the short cartridge—that is, the .32 Smith & Wesson. These firms also make revolvers chambered for the .32/20, but these are in the larger frame type.

Both the .32 Smith & Wesson Long and the .32 Colt New Police may be obtained in black and smokeless loads, and with lead or metal point bullets.

Name	.32 Smith & Wesson Long
Bullet weight	98 grains
Bullet diameter	.313 inch
Bullet length	.58 inch
Diameter of cartridge head	.374 "
Diameter of cartridge mouth	.336 "
Length of case	.92 "
Length loaded cartridge	1.27 "
Typical factory powder charge	2.1 grains Bullseye
Pressure	9,000 pounds per square inch
Velocity in 6 inch barrel	750 feet per second
Muzzle energy	124 foot pounds
Velocity, Peters make	720 feet per second
" Remington make	790 " " "
" Remington black powder load	820 " " "
" Western make	775 " " "
" Winchester make	810 " " "
Penetration ⅞ inch pine boards	4½ boards

Name	.32 Colt New Police
Bullet weight	100 grains
Bullet diameter	.3125 inch
Bullet length	.57 inch
Case dimensions	Same as for .32 S. & W. Long
Length loaded cartridge	1.26 inch
Typical factory charge	2.0 grains Bullseye
Pressure	8,500 pounds per square inch
Velocity, 4 inch barrel	730 foot seconds
Energy	120 foot pounds

Bullet weights and velocities vary as follows:

Make	*Bullet weight*	*Velocity*
Peters	100 grains	730 f. s.
Remington	100 grains	730 f. s.
Western	98 grains	750 f. s.
Winchester	98 grains	706 f. s.

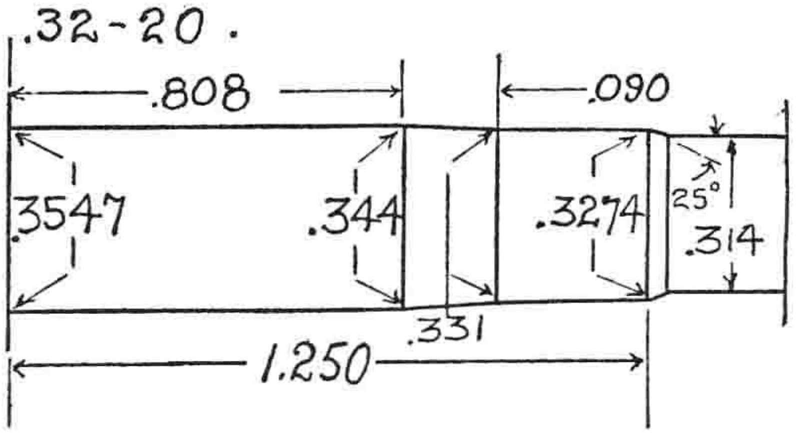
Reloading Data

Bullet name	Ideal 313249	Ideal 313249	lead
Bullet weight	87 grains	87 grains	85 grains
Powder, kind	Pistol No. 5	DuPont No. 80	Bullseye
Powder, charge	2.5 grains	3.4 grains	1.5 grains
Velocity	625	625	696
Recommended by	DuPont	DuPont	Hercules

.32 Winchester

This cartridge, which is also called the .32/20, was originally intended to have a 20-grain charge of black powder, hence the name. ".32/20." It has a 115-grain bullet as ordinarily loaded, though some companies use a 100-grain bullet. The full factory load generally runs a little under 20 grains of black powder, usually about 16 grains of FFG, which gives a velocity of about 970 foot-seconds with the 115-grain bullet. It is primarily a rifle cartridge, intended for the old Winchester Model 1873 rifle and afterwards for the Winchester Model 1892, for the Marlin, Remington and Colt repeating rifles and for the many single-shot rifles.

Revolvers were chambered for this cartridge in order to give the user of the rifle of this caliber out on the frontier a hand arm that would take the same cartridge, so that he would only have to carry one kind of ammunition. This worked out very well indeed in the old frontier days, when black powder was the only powder known, but when smokeless powders came into fashion a difficulty was met in that a smokeless powder that is well adapted for burning in a long rifle barrel will not burn well in a short revolver barrel, and vice versa. Accordingly, the .32/20, as it is now loaded, is more or less of a compromise intended primarily to give the best results in rifles, but loaded with the type of smoke-



The above is the chamber for the .32-20 (.32 Winchester) cartridge, the Single Action Army, the Official Police, and the Police Positive Special are now made for this cartridge. This chamber was formerly used in the following arms, now obsolete; New Army, New Navy, Bisley Model; also in the Army Special, now known as the Official Police.

less powder that will perform fairly well in revolvers. It is loaded usually with Sharpshooter powder, which is a nitroglycerin powder and is very erosive on gun barrels.

The .32/20 is the highest power .32 made for revolvers. It has a 115-grain bullet with nearly 1,000 foot-seconds velocity and a flat point that adds more shock power than the caliber would otherwise give. In spite of the disadvantage of not being primarily a revolver cartridge, it is quite a favorite, as is shown by the fact that Smith & Wesson make a gun called the "Winchester" for it.

This cartridge is quite accurate when properly loaded; but there is more variation between the different makes in this cartridge than in most calibers, and they do not all perform equally well in revolvers. It is therefore a good plan for the user of a .32/20 caliber revolver to experiment until he finds the make of .32/20 ammunition that performs best and then stick to it.

In recent years the cartridge companies have improved this cartridge for rifle use by loading it with a more powerful load, and these new cartridges are called "High-Speed" or "High-Velocity" cartridges, and have a pressure too high to be safe in revolvers. Before using .32/20 cartridges in revolvers, read the box label carefully. The High-Velocity type are marked "Not for use in revolvers," or something to that effect.

Bullet diameter	.312 inch
Bullet weight	115 grains or 100 grains
Bullet length	.54 inch
Diameter cartridge head	.405 “
“ “ mouth	.325 “
Length cartridge case	131 “
Length loaded cartridge	1.60 “
Typical factory charge, black powder	16 grains F. F. G.
“ “ “ smokeless powder	9.0 grains Sharpshooter
Pressure	17,000 pounds per square inch
Velocity, 6 inch revolver	954 foot seconds
Energy	230 foot pounds
Penetration, ⅞ inch pine boards	5 boards

Remington and Peters use a 100 grain bullet, while Western and Winchester use a 115 grain bullet; all four companies load to the same velocity, 954 f. s.

Reloading Data

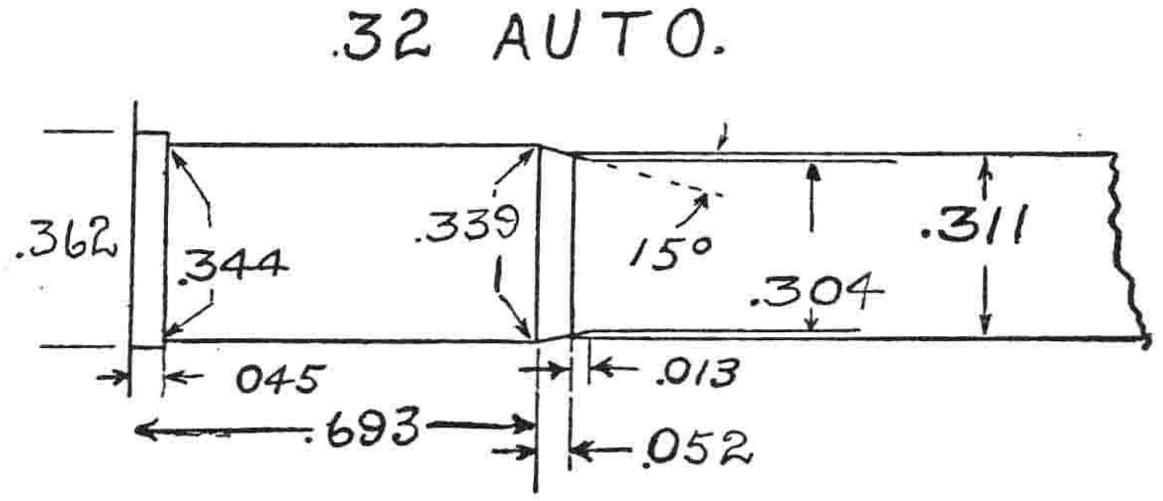
Bullet name	Belding & Mull 31198	Belding & Mull 31198	Bond C311655
Bullet weight	103 grains	103 grains	115 grains
Powder, kind	DuPont No. 80	Pistol No. 5	Bullseye
Powder, weight	9.5 grains	4.5 grains	4.5 grains
Velocity	1000 f. s.	903 f. s.	1042 f. s.
Recommended by	DuPont	DuPont	Hercules
Pressure			17,240 lbs.

The King Powder Company recommends the use of 16½ grains King's Semi-smokeless, granulation FG.

It is interesting to note that in spite of the fact that the .32 S. & W. cartridge is both smaller in diameter and much shorter than the .32-20, it can still be shot in the .32-20 revolver with fair accuracy. There is some danger, however, of split cartridges, owing to the fact that the chamber is larger than the case, and thus allows quite a lot of expansion to take place.

.32 Caliber (7.65 m/m) Automatic Colt Pistol Cartridge

This is a semi-rim automatic pistol cartridge, loaded with smokeless powder only, and having a 73 grain metal jacketed bullet driven at a muzzle velocity of about 950 feet per second. It is very popular for pocket automatic pistols, and has a wide use in both Europe and America. It is the next above the .25 automatic in the Colt and Browning series. In America it is known as the .32 A.C.P., (Automatic Colt Pistol), and in Europe it is called the 7.65 m/m automatic. It is used in the Colt, Savage, Remington, Smith & Wesson, Harrington & Richardson, Webley, Browning, Mauser, Clement, Frommer, Steyr, Pieper, Schwarzlose, Walther, and many other pocket automatics.



Bullet diameter	.314 inch
Bullet length	.46 inch
Bullet weight	.73 grains
Diameter cartridge head	.354 inch
" " mouth	.331 "
Length case	.93 inch
Length loaded cartridge	1.03 "
Factory charge	2.3 grains Bullseye
Pressure	14,000 lbs. per sq. inch
Velocity, 3¾ inch barrel	967 f. s.
Energy	154 ft. lbs.
Penetration, ⅞ inch pine boards	5 boards

The following variation in standards is noted:

Make	*Bullet weight*	*Velocity*
Peters	73 grains	965 feet per second
Remington	71 "	950 " " "
Western	74 "	950 " " "
Winchester	74 "	965 " " "

Reloading Data

Bullet name	Ideal 308252	Ideal 308252	Winchester full patch
Bullet weight	77 grains	77 grains	74 grains
Powder, kind	DuPont No. 80	Pistol No. 5	Bullseye
Powder, charge	4.5 grains	2.6 grains	2.1 grains
Velocity	950	950	829
Recommended by	DuPont	DuPont	Hercules

8 mm. Lebel

This cartridge which fits the French service revolver looks very much like our own .32-20. It is not often met with in this country. The bullet is copper jacketed, and the cartridge is loaded with black powder only.

Bullet weight	120 grains
Bullet diameter	.330 inch
Bullet length	.62 "
Diameter of cartridge head	.400 "
Diameter of cartridge body	.384 "
Length of case	1.06 "
Length of cartridge	1.45 "
Powder charge	11.5 grains fine black
Muzzle velocity	625 f. s.
Muzzle energy	104 ft. lbs.

8 mm. Nambu Cartridge

This is the cartridge used by the Japanese pistol of the same name. It is a bottle necked, rimless cartridge which at first glance looks very much like the .30 caliber Luger. I have never had an opportunity to make velocity or pressure tests on these cartridges as I have seen only a few samples which were brought to this country by persons who had purchased guns and ammunition of this kind while visiting in Japan. However, I have weighed and measured some samples with the following results:

Bullet weight	102 grains
Bullet diameter	.320 inch
Length of bullet	.60 "
Case length	.86 "
Length loaded cartridge	1.26 "
Diameter cartridge head	.413 "
Diameter cartridge case, rear	.408 "
Diameter cartridge case, neck	.388 "
Diameter cartridge case, mouth	.338 "
Powder charge	4 grains smokeless

.380 Revolver

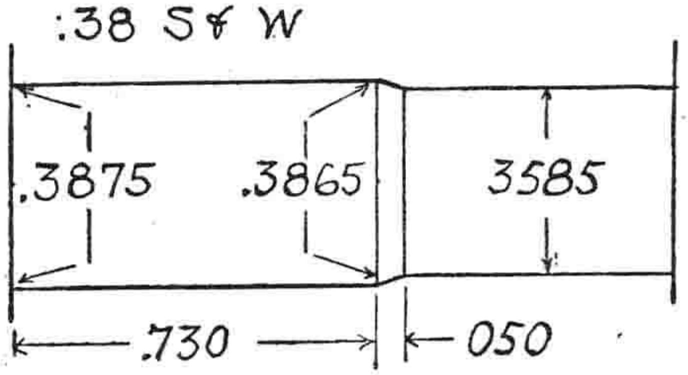
This is a short, low powered .38 cartridge with outside lubricated bullet, intended for foreign .38 caliber revolvers of old models. It is almost exactly the same as the .38 short Colt, about the only difference being that the rim of the .380 is .005 smaller in diameter and somewhat thicker.

Bullet weight	125 grains
Bullet diameter	.375 inch
Bullet length	.56 "
Diameter of cartridge head	.426 "
Diameter of cartridge body, front	.377 "
Length of case	.69 "
Length of cartridge	1.10 "
Powder charge	10 grains F. F. F. G. Black
Muzzle velocity	650 f. s.
Energy	120 ft. lbs.

.38 Smith & Wesson
.38 Colt New Police (Colt Police Positive)

The .38 S. & W. and the .38 Colt New Police, (which is the same cartridge with a flat pointed bullet), have for a long time been by far the most popular cartridges for pocket revolvers. Their popularity is deserved, for they are accurate, well designed cartridges, which have much greater stopping power than the .32 caliber.

The standard load for the .38 S. & W. is a 146 grain bullet with 2.3 grains of bull's-eye, or 3.8 grains of Pistol Powder No. 5, giving a muzzle velocity of about 730 feet per second and a muzzle energy of about 170 foot pounds.



This chamber will accommodate either the .38 S. & W. cartridge or the .38 Colt New Police cartridge. It is used in the Police Positive and Banker's Special revolvers.

The .38 Colt New Police has a flat point bullet of 150 grains weight, with about 710 foot seconds of velocity and 170 foot pounds energy. The flat pointed Colt New Police bullet is far superior to the round nosed .38 S. & W. in stopping power, and should always be used in preference to it.

Name	.38 Smith & Wesson
Bullet weight	146 grains
Bullet diameter	.359 inch
Bullet length	.67 "
Diameter of cartridge head	.433 "
Diameter of cartridge case	.383 "
Case length	.77 "
Length loaded cartridge	1.20 "
Powder charge	2.3 grains Bullseye
Pressure	8,000 pounds
Velocity	730 f. s.
Energy	170 foot pounds
Penetration ⅞ inch pine boards	5 boards

Name	.38 Colt New Police (Police Positive)
Bullet weight	150 grains
Bullet diameter	.359 inch
Bullet length	.65 "
Case dimensions	As above for .38 S. & W.
Powder charge	2.1 grains Bullseye
Pressure	9,000 pounds
Velocity	710 foot seconds
Energy	170 foot pounds

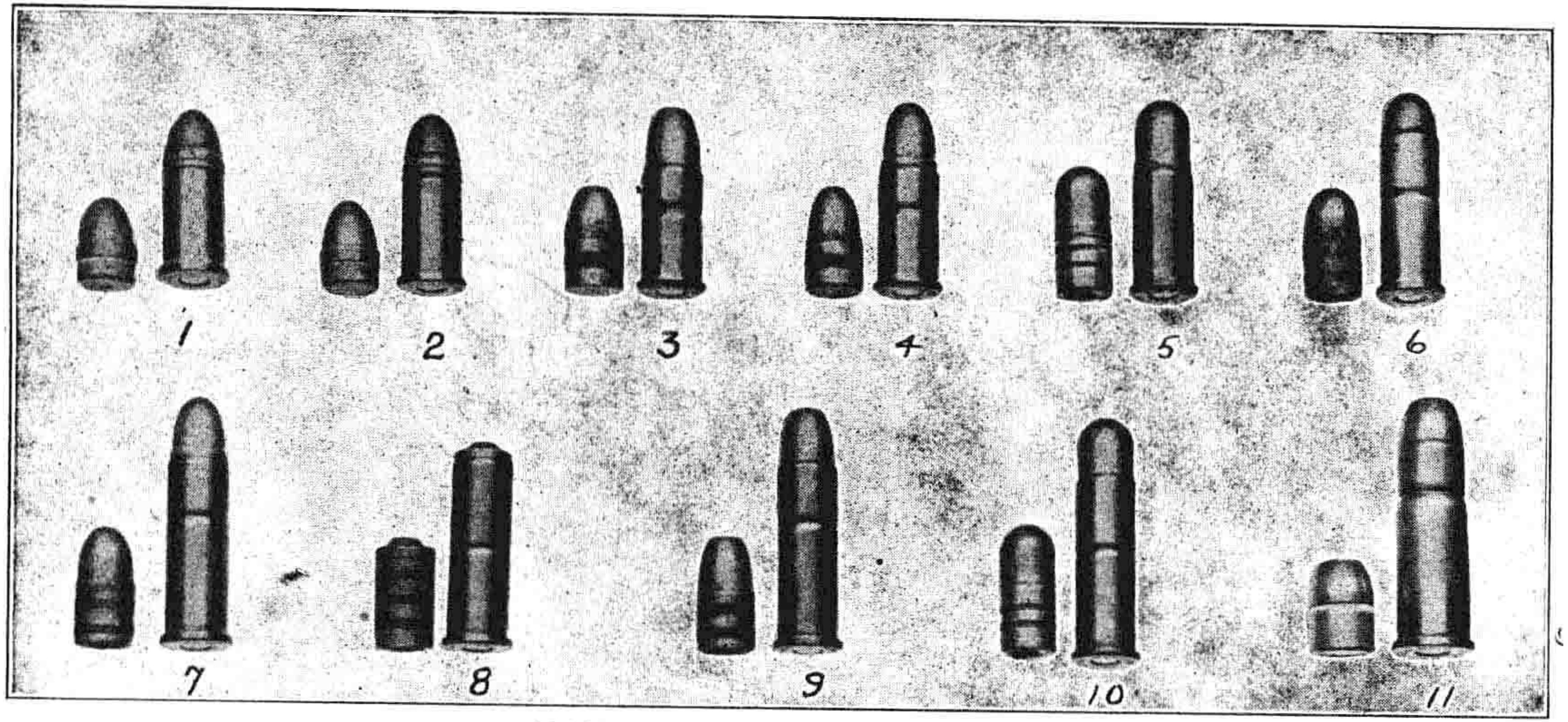
Reloading Data

Bullet name	Ideal 358246	Ideal 358246	Ideal 358246
Bullet weight	147	147	147
Powder, kind	Pistol No. 5	S. R. No. 80	Bullseye
Powder, weight	3.8 grains	5.9 grains	2.0 grains
Velocity	796	816	710
Recommended by	Ideal Handbook	Ideal Handbook	Ideal Handbook

.38 S. & W. Super Police

This is a cartridge made by the Western Cartridge Company for the solid frame revolvers chambered for the .38 S. & W. cartridge. However, instead of having a 146 grain bullet, as is standard for the .38 S. & W., this cartridge has a 200 grain, soft lead bullet. On account of the additional bullet weight the muzzle velocity is quite low. Moreover, the additional weight in the bullet increases the jump of the gun when fired and thus causes the group to be several inches higher than that of the regular .38 S. & W. at a range of twenty yards. The slow velocity causes the bullet to drop somewhat faster than the ordinary bullet and this additional drop counteracts most of the tendency to group high at the longer ranges. The object of this design is to produce a bullet which will have superior stopping power. With this end in view the nose of the bullet has been made quite blunt which undoubtedly adds considerably to the stopping power.

A number of tests, made by the author to determine whether or not this low velocity, heavy bullet load has greater stopping power than the regular load were inconclusive. If anything these



.38-CALIBER REVOLVER CARTRIDGES

1. .38 Short Colt
2. .380 Revolver (black)
3. .38 Colt New Police
4. .38 Smith & Wesson
5. .38 S. & W. "Super-Police"
6. .38 Long Colt
7. .38 S. & W. Special
8. .38 Special Mid-Range
9. .38 Colt Special
10. .38 Special "Super-Police"
11. .38 Winchester (.38/40)

tests seemed to indicate that the .38 Colt New Police cartridge has more stopping power than either the .38 S. & W. or the .38 Super Police. However, as stated before, the tests were not very conclusive as about the only way to make such a test that would be satisfactory would be to shoot live animals and even in this case no two animals are alike and no two shots would strike exactly the same.

The following is quoted from a letter received from the Western Cartridge Company: "A policeman shot a hold-up artist in East St. Louis the other day with this Super Police. Hit him square in the center of the back at 75 yards which was a darn good shot. When the coroner dug the bullet out of the crook he found it more than half way through him and flattened on the point to about the size of a quarter. This officer was certainly good. He had two hold-up artists, one of whom broke and ran. Without further ceremony he cracked one over the head with his revelver, took deliberate aim at the other and made a dead center bull's-eye on him."

The .38 Super Police cartridge is not recommended for use in jointed frame revolvers with tip-up action as the jar of the recoil has a tendency to unlatch the action.

Bullet weight	200 grains
Bullet diameter	.359 inch
Bullet length	.81 "
Cartridge case dimensions	Same as .38 S. & W.
Length of cartridge	1.24 inch
Weight of powder charge	2.5 grains Infallible
Velocity, 6" barrel	610 f. s.
Energy	166 ft. lbs.
Penetration, ⅞" pine boards	4 boards

.38 Short Colt

This is a cartridge adapted to the original Colt .38 Double Action revolver, and to other revolvers of this caliber, which are now obsolete. It will, however, shoot in the Colt .38 Army Revolvers chambered for the .38 Long Colt, and in all revolvers chambered for the .38 Special. It has an outside lubricated bullet weighing 125 grains in the Remington and Peters makes, and 130 grains in the Western and Winchester makes. The standard charge is 2.5 grains of Bull's-eye or 3.5 grains of Pistol powder No. 5.

Bullet weight	125 grains or 130 grains
Bullet diameter	.375 inch
Bullet length	.56 "
Diameter of cartridge head	.433 "
Diameter of cartridge mouth outside	.383 "
Case length	.69 "

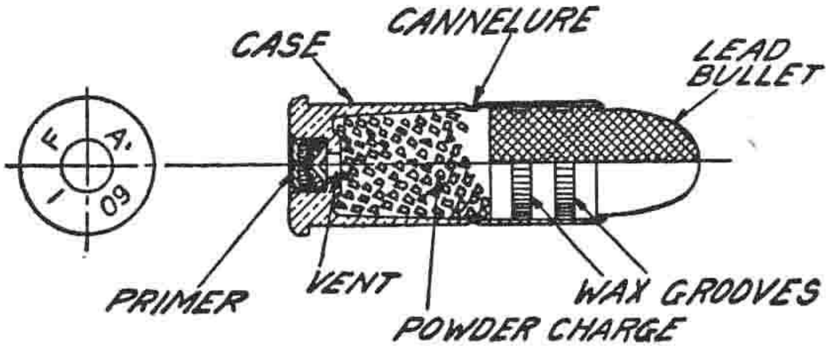
Length loaded cartridge	1.10 "
Muzzle velocity, 6 inch barrel	775 f.s. (Western 130 gr.)
Muzzle energy	173 foot pounds
Penetration, ⅞ inch pine boards	5 Boards

Reloading Data

Bullet name	Cast lead	Cast lead	Ideal 358159
Bullet weight	130 grains	130 grains	125 grains
Powder kind	King's Semi-smokeless	Bullseye	Pistol No. 5
Powder charge	14 grains FFG	2.5 grains	2.7 grains
Velocity	765 f.s.	745 f.s.	700 f.s.
Recommended by	King Powder Co.	Hercules	DuPont

.38 Long Colt

This cartridge is of interest because it was for years the military cartridge of the United States Government. Thousands of Colt and Smith & Wesson revolvers, chambered for this gun, were issued to the Army and Navy and were the standard side arm for many years. Therefore, there are vast numbers of these guns still in the hands of the public, and for this reason the .38 Long Colt cartridge will continue to be manufactured for years, though all the modern military .38's that are manufactured are chambered for the longer .38 Special, and none now manufactured are chambered for the long Colt.



CAL..38 REVOLVER BALL CARTRIDGE

This bullet as originally made was smaller than the diameter of the barrel and had a hollow base so that the powder pressure would expand the bullet and make it take the rifling.

On account of the fact that this was the standard military cartridge it has been thoroughly investigated by our Ordnance Department, and the data available on this cartridge are much more complete than on most other cartridges. Ordnance Pamphlet No. 1919 gives the following data on the .38 Long Colt Cartridge, which is very interesting in showing about how a revolver cartridge of .38 caliber will behave ballistically, because the results on the .38 Special will not be far different:

ACCURACY

Range, yards	*Mean hor. dispersion, inches*	*Mean vert. dispersion, inches*	*Mean radius, inches*
25	.668	.515	.903
50	.604	1.400	1.553
75	2.278	1.612	2.888
100	2.400	1.994	3.656
150	2.762	7.296	8.018
200	4.600	16.990	9.255

NOTE: The group diameter is about three times the mean radius.

DRIFT

Range, yards	*Drift, inches*
25	0.75
50	1.09
75	1.57
100	2.24
150	7.80

NOTE: This was obtained by having special guns made up with right and left-hand twist for use in this experiment.

PENETRATIONS IN WHITE PINE

Range, yards	*Depth, inches*
25	4.97
50	4.35
75	4.26
100	3.64
150	3.05
200	2.90

NOTE: One inch corresponds to a dangerous wound.

REMAINING VELOCITY WITH FORCE OF IMPACT

Range, yards	*Velocity, feet per second*	*Force of impact, foot-pounds*
25	689.9	155.2
50	671.9	147.2
75	654.5	139.7
100	637.5	132.5
125	620.9	125.7
150	604.8	119.3
175	589.09	113.2
200	573.8	107.4

Bullet weight	148 grains
Bullet diameter	357 inch
Bullet length	.72 “
Diameter cartridge head	.433 “
Outside diameter case mouth	.377 “
Length of case	1.03 “
Length loaded cartridge	1.32 “
Factory charge	3.0 grains Bullseye
Pressure	12,000 pounds
Velocity, 6 inch barrel	810 foot seconds
Energy	230 foot pounds
Penetration, ⅞ inch pine boards	7 boards

Reloading Data

Bullet name	Ideal 35870	Ideal 35870	Cast lead
Bullet weight	150 grains	150 grains	148 grains
Powder, kind	Pistol No. 5	S. R. No. 80	Bullseye
Powder, charge	3.6 grains	6.2 grains	3.0 grains
Velocity	815 f.s.	795 f.s.	810 f.s.
Recommended by	Ideal handbook	Ideal handbook	Hercules

.38 S. & W. Special. .38 Colt Special

This is an extremely accurate cartridge and is the most popular of all center fire revolver cartridges for target shooting. It has superb accuracy and is capable of making groups of less than 1½ inches in diameter at fifty yards.

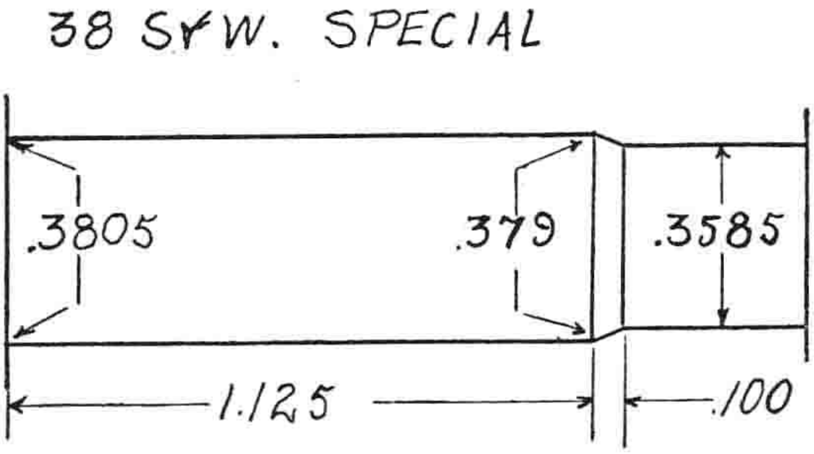
The .38 Special has a very great popularity in almost every field of use, as it is large enough and powerful enough for military use and at the same time it is not too large for pocket revolvers. The most powerful pocket guns are chambered for this cartridge which is a favorite with Police Departments. There is also a line of military revolvers made for this cartridge which have become extremely popular as target arms; and our most popular special target revolvers are chambered for this cartridge. It is the cartridge that has been most hand loaded and there are a tremendous number of bullets furnished for it by the reloading company and a large variety of hand loads from which to choose.

It is regularly made and stocked by the cartridge companies not only in full loads but also in mid-range loads with square shouldered bullets, in special target loads which have a still further reduced weight of bullet and in a special gallery load with a round ball.

Recently this cartridge has been produced loaded to a very high velocity, especially for use in the new Smith & Wesson .38/44 revolver and other .38's on .44 or .45 frames. These new ultra powerful cartridges are the same in every respect except the velocity as the regular .38 Special and are sold under the name of .38/44 S. & W. Special, .38 S. & W. Special High Velocity or .38 Colt Special High Velocity.

The .38 Special cartridge is both accurate and powerful and has plenty of penetration, but does not have nearly as great stopping power as the .45 merely on account of the smaller diameter of the bullet.

The original .38 Special has a bullet with a rounded nose; in order to improve the stopping power of this cartridge the Colt Company induced the cartridge makers to make the same cartridge with a bullet having a flat space on the nose. This flat space adds greatly to the effectiveness of the bullet as regards stopping power. When this cartridge is being used for self-protection or any other purpose but target practice, the Colt Special rather than the Smith & Wesson Special should be obtained. An even more effective shape from the viewpoint of stopping power is the bullet designed by Elmer Keith which has a flat point with a ledge around the body of the bullet just forward of the cartridge case.



Were it necessary for the average shooter to own and use but one revolver it should be a .38 Special.

Name	.38 S. & W. Special
Bullet weight	158 grains
Bullet diameter	.359 inch
Bullet length	.74 "
Diameter of cartridge head	.433 "
Diameter of cartridge body	.377 "
Length of case	1.16 "
Length of cartridge	1.55 "
Powder charge	3.6 grains Bullseye
Pressure	15,000 lbs.
Muzzle velocity, 6 inch barrel	860 f.s.
Muzzle energy	260 ft. lbs.
Penetration, ⅞ inch pine boards	7 boards

Name	.38 Colt Special
Bullet weight	158 grains
Bullet length	.71 inch
Length of cartridge	1.51 "
Other dimensions	Same as .38 S. & W. Special
Ballistics	Same as .38 S. & W. Special

Name	.38/44 S. & W. Special
Bullet and cartridge dimensions	Same as .38 S. & W. Special
Muzzle velocity	1100 f.s.
Muzzle energy	425 ft. lbs.

Name	.38 Colt Special, High Velocity
Bullet and cartridge dimensions	Same as .38 Colt Special
Ballistics	Same as .38/44 S. & W. Special

Reloading Data

Bullet name	Ideal 358311	Ideal 358311	Ideal 358311
Bullet weight	158 grains	158 grains	158 grains
Powder, kind	Pistol No. 5	Bullseye	King's S. S., FFG
Weight of charge	5.0 grains	3.0 grains	18 grains
Velocity	950 f.s.	790 f.s.	820 f.s.
Recommended by	Ideal Handbook	Ideal Handbook	King Powder Co.

The hand loads given above approximate the regular factory charge. The shooter interested in hand loading will find literally dozens of other hand loads both more and less powerful listed in the works on reloading and the hand books of the loading tool makers.

.38 Special Super Police

With the idea of increasing the stopping power of the .38 Special cartridge, the Western Cartridge Company sometime ago placed on the market a .38 S. & W. Special cartridge with a 200 grain, blunt nosed bullet instead of the standard 158 grain bullet. This is called the .38 Special Super Police. On account of the heavier bullet this cartridge has a lower velocity than the standard .38 Special; but the heavier bullet also causes more jump so that the group goes several inches higher at twenty yards with the .38 Special Super Police than it does with the regular .38 Special.

As the object of this bullet is increased shock power the author made numerous tests to determine whether or not this bullet has more stopping power than the regular .38 Special. While the tests were inconclusive the results seemed to indicate that perhaps the .38 Colt Special has more stopping power than either the .38 S. & W. Special or the .38 Special Super Police.

The following is quoted from a letter received from the Western Cartridge Company. "This 200 grain bullet of ours in the .38 Special Super Police is now being used in considerable quantity by the St. Louis Police Department. We, therefore, have an opportunity to watch its effectiveness. Three times this month it has proven instantly effective, that is, it has put the bandit flat on his back at the first crack. Each time penetration has been clear through. One shot struck just forward of the hip bone on the right side, ranged downward, smashed the pelvis and came out in the left hip. Second instance, shot struck at base of skull in the rear, ranged through and came out at bridge of nose. Third instance, shot struck in front of left ear, ranged through and came out the base of neck on the right hand side."

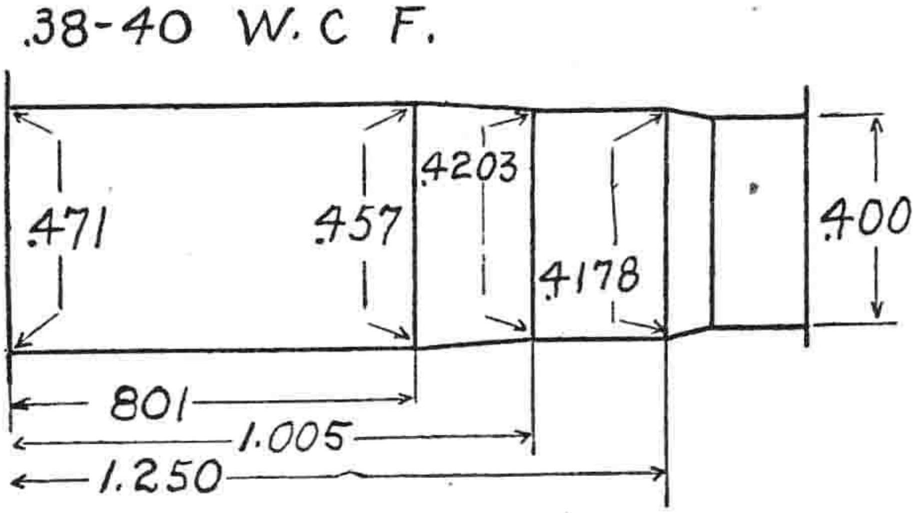
In a number of tests made by the makers of this bullet to determine the velocity and different barrel lengths, the results were as follows:

Barrel Length	*Standard .38 Special*	*.38 Special Super Police*
2"	723 f.s.	623 f.s.
6"	818 "	671 "
7½"	791 "	656 "

Bullet weight	200 grains
Bullet diameter	.355 inch
Bullet length	.81 "
Cartridge dimensions	Same as .38 S. & W. Special
Powder charge	4 grains Infallible
Velocity, 6 inch barrel	725 f.s.
Energy	246 ft. lbs.
Penetration, ⅞ inch pine boards	5 boards

.38 Winchester (.38-40)

Like the .32-20, this is a rifle cartridge, intended for the old-style Winchester rifles and for which revolvers were also chambered, so that the user could have both a rifle and a revolver and only one kind of ammunition. In common with the .32-20 and .44-40, this cartridge is still loaded primarily for rifle use with a compromise type of powder known as "Sharpshooter," which is a nitroglycerin powder and rather erosive. This cartridge has a 180-grain flat-point bullet with a muzzle velocity of 950 foot-seconds and a muzzle energy of 360 foot-pounds. Because of its comparatively light bullet weight and the square nose which adds to air resistance, this bullet does not carry up as well at long distances as the .44 Special and other advanced designs.



This cartridge is called ".38-40" because it was originally loaded with 40 grains of black powder.

The bullet diameter of this cartridge is .400; therefore this is really a .40 caliber. Owing to the large size of the bullet and the flat point, it has very good stopping power. Like the .32-20, this cartridge has been made recently in the high-speed or high-velocity types, which are too powerful for use in revolvers as they are likely to burst the cylinder.

Bullet weight	180 grains
Bullet diameter	.400 inch
Bullet length	.60 "
Diameter cartridge head	.545 "
Diameter cartridge body	.414 "
Length of case	1.31 "
Length of loaded cartridge	1.60 "
Powder charge	16.0 grains Sharpshooter
Pressure	14,000 lbs.
Velocity, 5.5 inch barrel	950 f.s.
Energy	360 ft. lbs.
Penetration, ⅞ inch pine boards	7 boards

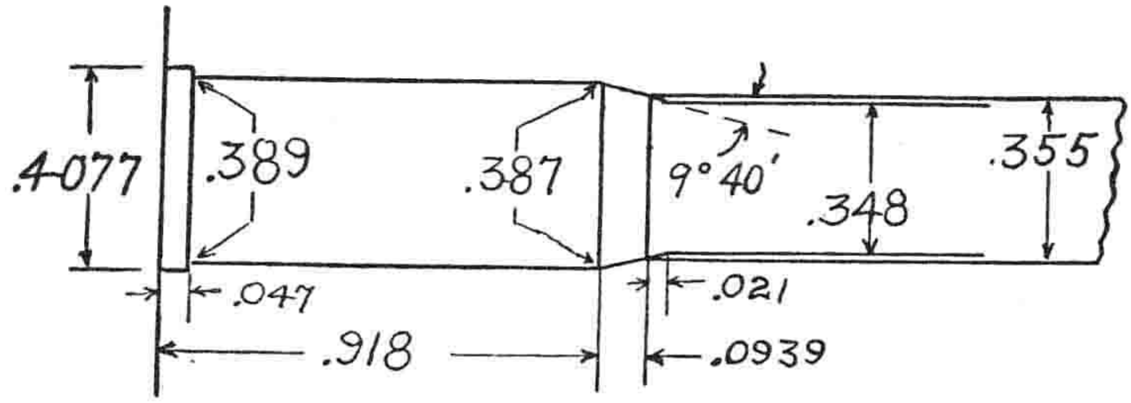
Reloading Data

Bullet name	Ideal 40043	Ideal 40043	Ideal 40043
Bullet weight	180 grains	180 grains	180 grains
Powder, kind	S. R. No. 80	Bullseye	King's S. S., FG
Weight of charge	14.8 grains	4.0 grains	33 grains
Velocity	1030 f.s.	700 f.s.	850 f.s.
Recommended by	Ideal Handbook	Ideal Handbook	King Powder Co.

.38 A.C.P. (Automatic Colt Pistol)

This is a high velocity semi-rim type, automatic pistol cartridge resembling the 9 mm. Luger in size and general appearance. It is however, somewhat more powerful than the Luger as it has a slightly heavier bullet and a somewhat higher velocity. It was designed for the first high powered Browning automatic pistol, which became the Colt .38 Military. This cartridge had excellent ballistics but for a good many years it did not become very popular on account of the fact that the arm which it fitted was designed as a military side arm in 1904 but was not adopted by the Government which took the .45 instead. The .45 caliber automatic, after its adoption by the Government, was greatly improved to meet

.38 AUTOMATIC



the military requirements and to overcome the defects and disadvantages brought out by the test for adoption. Thus the .45 caliber automatic pistol became very much superior mechanically to the old .38 Military and shooters who otherwise would have liked to avail themselves of the excellent ballistics of this cartridge very frequently were restrained from doing so by the fact that no gun of up-to-date design was available for it.

However, the Colt Company several years ago brought out a thoroughly up-to-date automatic pistol, the Super .38, for this cartridge. At the same time the cartridge companies improved the ballistics of the cartridge somewhat by raising the velocity from 1126 foot seconds to 1200 foot seconds. This cartridge has more penetration and more energy than any other American pistol cartridge but it does not have the stopping power of the .45. An exception is that it is better than the .45 for use against very large animals in which the bullet will stop in spite of its great penetration. In such animals the Super .38 can be depended on to reach vital spots, and the deep penetration means that the energy of the bullet is distributed over a long track which increases the stopping power. This cartridge can be had in the hollow point style as well as the standard full metal jacket.

Bullet weight	130 grains
Bullet diameter	.359 inch
Bullet length	.58 "
Diameter of cartridge head	.403 "
Diameter of cartridge body	.382 "
Length cartridge case	.90 "
Length loaded cartridge	.127 "
Smokeless powder charge	4.6 grains Bullseye
Pressure	28,000 pounds
Muzzle velocity, 5 inch barrel	1200 f.s.
Energy	417 ft. lbs.
Penetration, ⅞ inch pine boards	11 boards

Reloading Data

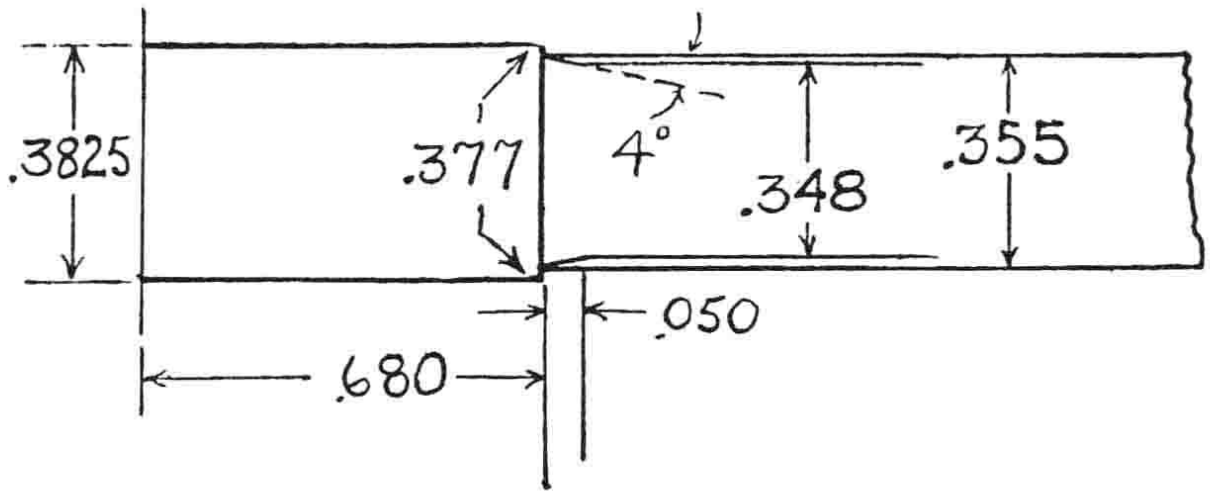
Bullet name	Ideal 358422	Ideal 358422
Bullet weight	125 grains	125 grains
Powder, kind	Pistol No. 5	Bullseye
Weight of charge	5 grains	4 grains
Velocity	1100 f.s.	1100 f.s.

.380 Automatic (9 mm. Short)

This is a rimless, automatic pistol cartridge with a metal jacketed bullet, suitable for a medium size, pocket, automatic pistol such as the Colt, Remington, Savage, Browning, Bayard and many others. It is far superior to the .32 A.C.P. because its larger diameter gives it greater stopping power.

Bullet weight	95 grains
Bullet diameter	.356 inch
Bullet length	.46 "
Diameter of cartridge head	.372 "
Diameter of cartridge body	.372 "
Length of case	.68 "
Length of cartridge	.93 "
Powder charge	2.5 Bullseye
Muzzle velocity, 3.75 inch barrel	870 f.s.
Muzzle energy	160 ft. lbs.
Penetration, ⅞ inch pine boards	5 boards

380 AUTO.



9 mm. Long

This is a semi-rim automatic pistol cartridge somewhat more powerful than the .380 and somewhat less powerful than the .38 A.C.P. It is used in the Webley, Browning and other European pistols. There is no American pistol made for this cartridge.

Bullet weight	110 grains
Bullet diameter	.355 inch
Bullet length	.51 "
Diameter cartridge head	.404 "
Diameter cartridge body	.384 "
Length of case	.80 "
Length of loaded cartridge	1.10 "
Powder charge	
Velocity, 5 inch barrel	1110 f.s.
Energy	300 ft. lbs.
Penetration, ⅞ inch pine boards	8 boards

9 mm. Luger

This is a German cartridge that has been very much used in this country. It is a high-velocity cartridge with a bullet weighing 125 grains. The standard bullet diameter is .355, and the velocity is around 1,040 foot-seconds. It is made in a metal-jacketed bullet with a square point. The bullet has a peculiar shape. It is conical; but the point is square, so that the actual shape of the front part of the bullet is that of a truncated cone. The square shape adds somewhat to the stopping power of the bullet and also partly prevents it from glancing.

These Luger cartridges are sometimes loaded with "double" or divided bullets with the idea of increasing the probability of hitting in the case of a poor marksman. During the World War a number of Mauser pistols were made in 9 mm. for this same cartridge, and the Luger cartridge was seen with the round nose instead of with the ordinary conical-shaped bullet.

The Remington Arms Company loads the Luger cartridge with a 124 grain bullet to a velocity of 1210 f.s. measured in the 8 inch barrel model. This gives 400 foot pounds of energy.

Bullet weight	125 grains
Bullet diameter	.354 inch
Bullet length	.61 "
Diameter cartridge head	.392 "
Diameter cartridge body	.377 "
Length of case	.76 "
Length of loaded cartridge	1.16 "
Powder charge	5.5 grains Smokeless
Pressure	24,000 pounds
Velocity, 4 inch barrel	1075 f.s.
Energy	320 ft. lbs.
Penetration, ⅞ inch pine boards	9 boards

Reloading Data

Bullet name	Ideal 356402	Ideal 356402
Bullet weight	123 grains	123 grains
Powder, kind	Pistol No. 5	Bullseye
Weight of charge	6 grains	4.8 grains
Velocity	1135 f.s.	1120 f.s.
Recommended by	Mattern	Mattern

9 mm. Bayard

The Bayard automatic pistol, model of 1910, is the standard of the Danish army. It was also much used by the Germans during the World War. The cartridge is very powerful and is similar to the .38 automatic Colt in size and shape. It is a rimless case and has a jacketed bullet. The case appears to be straight but measurements show that it has a considerable taper from front to rear to facilitate extraction.

Bullet weight	126 grains
Bullet diameter	.355 inch
Bullet length	.60 "
Diameter of cartridge head	.392 "
Diameter of cartridge body, rear	.390 "
Diameter of cartridge body, front	.375 "
Length of case	.90 "
Length of cartridge	.131 "

Powder charge	5.6 grains Smokeless
Muzzle velocity	1148 f.s.
Energy	365 ft. lbs.

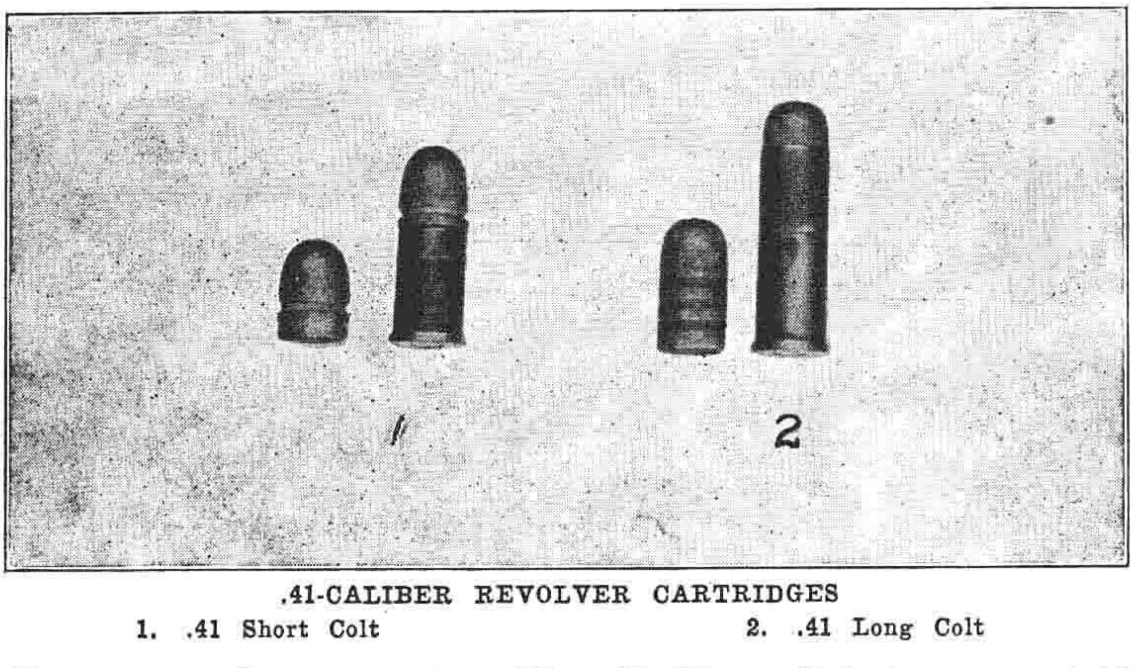
9 mm. Steyr

This cartridge is almost exactly the same size and shape as the 9 mm. Bayard described above and comes in clips of eight. The bullets are steel jacketed and in spite of the fact that they are plated over with a protective coating they have quite a tendency to rust.

Bullet weight	116 grains
Bullet diameter	.355 inch
Bullet length	.60 "
Diameter of cartridge head	.381 "
Diameter of cartridge body	.381 "
Length of case	.90 "
Length of cartridge	.130 "
Powder charge	6.2 grains Smokeless
Muzzle velocity	1200 f.s.
Muzzle energy	370 ft. lbs.

.41 Short Colt

This cartridge is still manufactured for use in the .41 Colt revolvers still in the hands of the public although revolvers of this caliber are no longer made. The .41 Short Colt has an outside lubricated bullet and was originally loaded only with black powder though at the present time smokeless loads are the rule.



.41-CALIBER REVOLVER CARTRIDGES
1. .41 Short Colt 2. .41 Long Colt

Bullet weight	160 grains
Bullet diameter	.406 inch
Bullet length	.57 "
Diameter cartridge head	.435 "

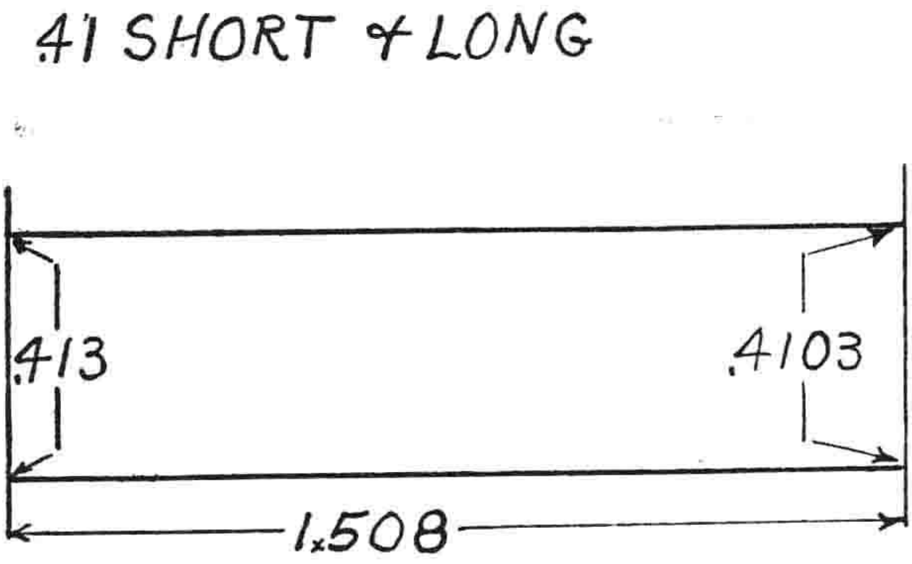
Diameter cartridge body	.404 "
Length of case	.65 "
Length of loaded cartridge	1.10 "
Powder charge	2.7 grains Bullseye
Pressure	12,000 lbs.
Velocity, 6 inch barrel	672 f.s.
Energy	160 ft. lbs.
Penetration, ⅞ inch pine boards	4 boards

Reloading Data

A satisfactory load for this cartridge as recommended by King's Powder Company is the 160 grain bullet and 15 grains of King's Semi-smokeless FFG.

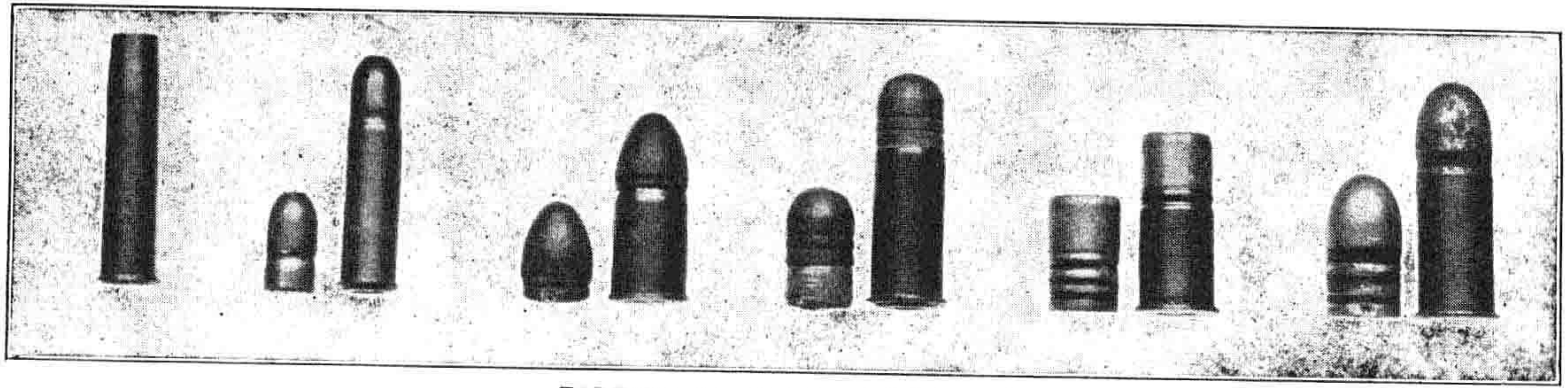
.41 Long Colt

At one time the Colt .41 Revolver was a famous and popular arm out West and it is still much used in certain sections of the South though it is not made at the present time. Both the .41 Short and .41 Long cartridges can be used interchangeably in these guns.



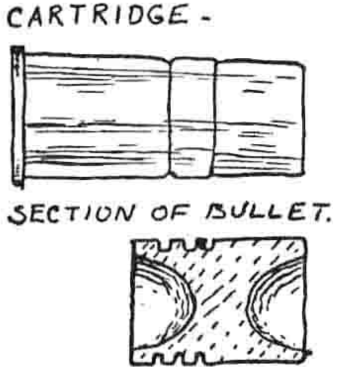
STANDARD CHAMBER DIMENSIONS OF COLT REVOLVERS AND PISTOLS
This chamber, for the .41 Short Colt and .41 Long Colt is no longer made. It was formerly used in the New Army, New Navy, Colt Army Special, Single Action Army, and Bisley Model revolvers.

The .41 Long Colt originally had an outside lubricated bullet with a heel of smaller diameter fitting into the neck of the cartridge case. However, it is now loaded as an inside lubricated cartridge and as a result the whole bullet is of the diameter of the former heel. To compensate for this the base of the bullet is made hollow so it will swell out from the powder pressure and thus fit the rifling.

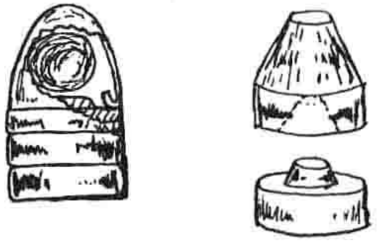


FOREIGN REVOLVER CARTRIDGES

1. .30 Nagant
2. 8-mm. French Revolver, Model of 1892
3. 11-mm. French Revolver, Model of 1873
4. 11-mm. German Revolver, Model of 1888
5. .455 Webley "Manstopper"
6. .476 Eley



WEBLEY MANSTOPPER
220 GR. BULLET WITH
HOLLOW POINT AND BASE.



TWO MODERN MAN-STOPPERS
LEFT, REMINGTON "RIOT" 45
RIGHT, MULTIPLE BALL FOR
THE LUGER 9 m/m CTG.

Bullet weight	195 grains
Bullet diameter	.388 inch
Bullet length	.73 "
Diameter cartridge head and body	Same as .41 Short Colt
Length of case	1.13 inch
Length of loaded cartridge	1.40 "
Powder charge	3.5 grains Bullseye
Pressure	14,000 lbs.
Velocity, 6 inch barrel	750 f.s.
Energy	255 ft. lbs.
Penetration, ⅞ inch pine boards	5 boards

Reloading Data

Bullet name	Ideal 386177	Ideal 386177	Ideal 386177
Bullet weight	196 grains	196 grains	196 grains
Powder, kind	Pistol No. 5	Bullseye	King's S. S., FG
Weight of charge	4.2 grains	3.0 grains	25 grains
Velocity	730 f.s.	700 f.s.	710 f.s.
Recommended by	Ideal Handbook	Ideal Handbook	King's Powder Co

11 mm. German Revolver Model 1888

This old German service revolver cartridge has very much the same appearance as the .41 Long Colt. It has a rather heavy load consisting of 262 grains bullet with 20½ grains of black powder.

Bullet weight	262 grains
Bullet diameter	.428 inch
Bullet length	.74 "
Diameter cartridge head	.504 "
Diameter cartridge body	.451 "
Length of case	.95 "
Length of loaded cartridge	1.21 "
Powder charge	20.5 grains black

11 mm. French Revolver Model 1873

In outside appearance this cartridge resembles the .44 Webley. This cartridge is hardly ever seen in America as arms chambered for it are rarely found in this country.

Bullet weight	176 grains
Bullet diameter	.454 inch
Bullet length	.60 "
Diameter cartridge head	.462 "
Diameter cartridge body	.448 "
Length of case	.68 "
Length of loaded cartridge	1.16 "
Powder charge	14 grains black
Velocity	700 f.s.
Energy	192 ft. lbs.

.44 Smith & Wesson American

This an old black powder cartridge, with outside lubricated bullet, which has been obsolete for many years, but is still made for the use of owners of the old .44 American Army revolver which was used in the service about 1871.

The name, .44 Smith & Wesson American was applied to this gun and cartridge to distinguish it from the .44 Russian model made by Smith & Wesson about the same period.

The cartridge is loaded principally with black powder, though both smokeless and semi-smokeless loads can also be obtained.

Bullet weight	218 grains
Bullet diameter	.434 inch
Bullet length	.70 "
Diameter of cartridge head	.502 "
Diameter of cartridge body	.437 "
Length of case	.90 "
Length of loaded cartridge	1.43 "
Powder charge	25 grains black
Velocity, 6 inch barrel	650 f.s.
Energy	200 ft. lbs.

Reloading Data

Bullet name	Ideal 414180	Ideal 414180	Cast lead
Bullet weight	200 grains	200 grains	205 grains
Powder, kind	Sport'g Rifle No. 80	Pistol No. 5	King's S. S., FFG
Weight of charge	12 grains	6.0 grains	20 grains
Velocity	800 f.s.	800 f.s.	650 f.s.
Recommended by	DuPont	DuPont	King Powder Co.

.44 Colt

Like the .44 Smith & Wesson American this is an old, black powder cartridge adapted to guns which are long ago obsolete. It has an outside lubricated bullet.

Bullet weight	210 grains
Bullet diameter	.444 inch
Bullet length	.66 "
Diameter of cartridge head	.483 "
Diameter of cartridge body	.451 "
Length of case	1.08 "
Length of cartridge	1.50 "
Muzzle velocity, 6 inch barrel	660 f.s.
Muzzle energy	200 ft. lbs.

.44 Bull Dog

This is an English cartridge adapted to pocket revolvers of that caliber and name. It has an outside lubricated bullet and is ordinarily loaded with black powder. However, smokeless loads can now be obtained.

Bullet weight	170 grains
Bullet diameter	.440 inch
Bullet length	.56 "
Diameter of cartridge head	.503 "
Diameter of cartridge body	.471 "
Length of case	.57 "
Length of cartridge	.95 "
Powder charge	15 grains black
Muzzle velocity, 4½ inch barrel	460 f.s.
Muzzle energy	80 ft. lbs.

.44 Webley

This cartridge, like the .44 Bull Dog, is an English cartridge made for pocket revolvers. It differs from the .44 Bull Dog principally in having a heavier bullet.

Bullet weight	200 grains
Bullet diameter	.436 inch
Bullet length	.64 "
Diameter of cartridge head	.503 "
Diameter of cartridge body	.471 "
Length of case	.69 "
Length of cartridge	1.11 "
Powder charge	18 grains black
Muzzle velocity, 4½ inch barrel	560 f.s.
Muzzle energy	140 ft. lbs.

For reloading use a 200 grain bullet and 15 grains of King's Semi-smokeless size FFG.

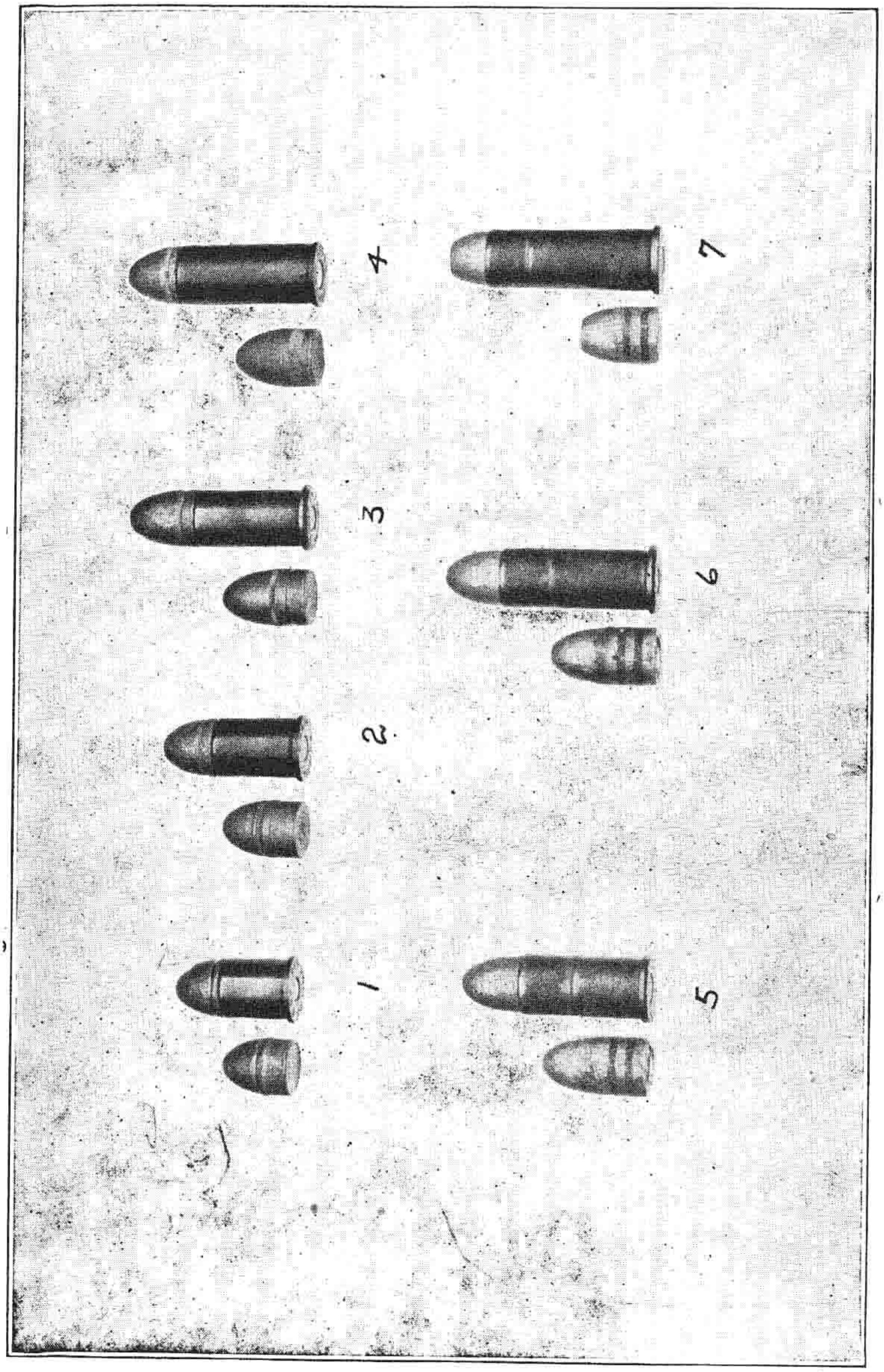
.44 Smith & Wesson Russian

This famous cartridge was designed by Smith & Wesson for their Russian model revolver which was the standard of the Russian Army at one time. It was the most accurate and popular cartridge for target shooting in the old black powder days. Such great marksmen as Chevalier Ira A. Paine and Mr. F. E. Bennett won their fame with this cartridge. A tremendous amount of experimental work was done with it and many special bullets were designed for it by hand loaders and many special loads were developed for it.

It has a small case which works exceptionally well with reduced smokeless powder loads for gallery shooting. Many marksmen prefer this caliber to the .22 or to the .38 for target work because the larger bullet hole is a decided advantage at short ranges where the targets are small, because very often the big bullet will cut the next higher ring where a smaller bullet will not.

The original bullet of this cartridge is the most accurate long range bullet that has ever been designed for revolver shooting. At 200 yards the cartridge is capable of making ten shot groups less than eight inches in diameter and good shooting can be done with this cartridge off hand up to ranges well over 300 yards.

Bullet weight	246 grains
Bullet diameter	.431 inch
Bullet length	.82 "
Diameter of cartridge head	.508 "
Diameter of cartridge body	.455 "
Length of case	1.02 "
Length of cartridge	1.43 "
Powder charge	23 grains black



.44-CALIBER REVOLVER CARTRIDGES

1. .44 Bull Dog (black powder)
2. .44 Webley (black powder)
3. .44 S. & W. American (black powder)
4. .44 Colt (black powder)
5. .44 S. & W. Russian
6. .44 S. & W. Special
7. .44 Winchester (.44-40)

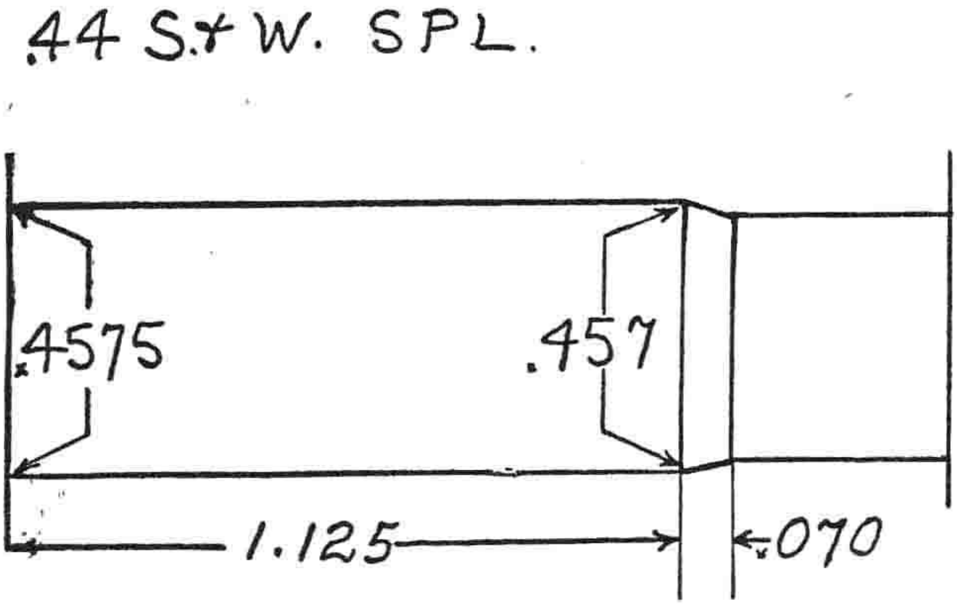
Muzzle velocity, 6 inch barrel	750 f.s.
Muzzle energy	316 ft. lbs.
Penetration, ⅞ inch pine boards	7 boards
Standard smokeless load	5.5 grains Bullseye

Reloading Data

Bullet name	Lead	Lead	Lead
Bullet weight	246 grains	246 grains	246 grains
Powder, kind	Pistol No. 5	Bullseye	King's S. S., FFG
Weight of charge	5.6 grains	5.5 grains	19 grains
Velocity	720 f.s.	674 f.s.	700 f.s.
Recommended by	DuPont	Hercules	King Powder Co.

.44 Smith & Wesson Special

When the first smokeless powders came into use, the cartridge case of the .44 Russian was not large enough to enable these powders to be used in full charges and to meet this difficulty a new cartridge was designed with the same bullet as the .44 Russian and a longer case. It retains the highly accurate .44 Russian bullet and equals the .44 Russian cartridge in accuracy while it excels it in power. It is by far the best designed of the large caliber revolver cartridges. Arms now chambered for the .44 Special will take the .44 Russian also, as the cartridge dimensions, except the length, are the same.



This chamber accommodates the .44 Russian and the .44 S. & W. Special cartridges. It is now used in the New Service, New Service Target, and Single Action Army Revolvers, and was formerly used in the Bisley Model.

A very large number of excellent hand loads have been developed for this cartridge and the man who loads his own can find in the hand books on reloading bullet weights and powder charges which adapt this cartridge to every purpose from gallery shooting and small game hunting up to long range shooting and protection against savage tribesmen in the far parts of the earth.

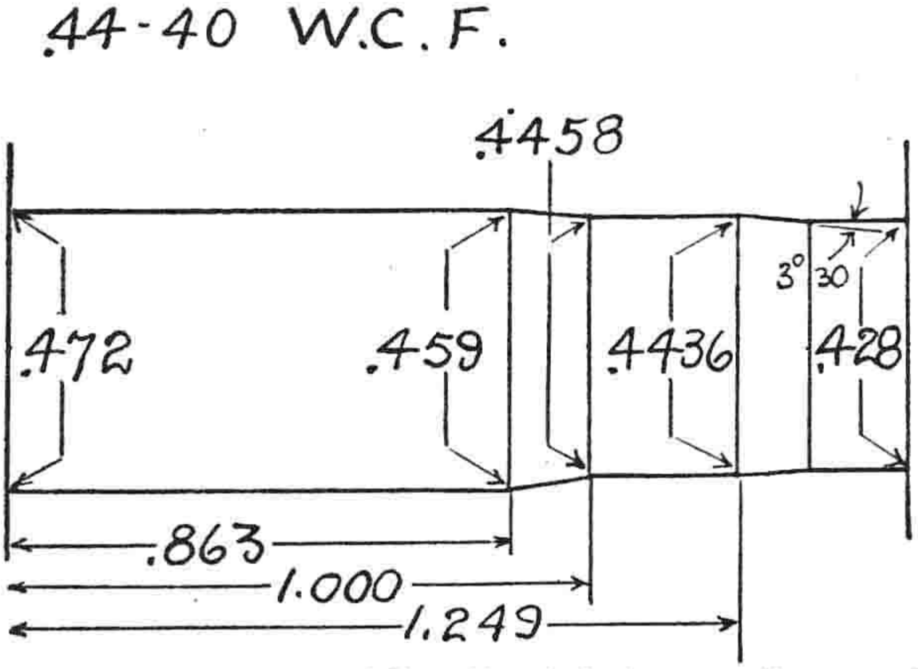
Bullet weight and dimensions	Same as .44 Russian
Length of case	1.17 inch
Length of cartridge	1.60 "
Other cartridge dimensions	Same as .44 Russian
Powder charge, black	26 grains black
Muzzle velocity, 6 inch barrel	780 f.s.
Muzzle energy	330 ft. lbs.
Penetration, ⅞ inch pine boards	7 boards
Powder charge, smokeless	6.0 grains Pistol No. 5

Reloading Data

Bullet name	Ideal 429352	Lead	Ideal 429352
Bullet weight	245 grains	246 grains	245 grains
Powder, kind	Pistol No. 5	Bullseye	King's S. S., FFG
Weight of charge	7 grains	6.3 grains	22.5 grains
Velocity	900 f.s.	740 f.s.	730 f.s.
Recommended by	DuPont	Hercules	King Powder Co.

.44 Winchester (.44-40)

Like the .32-20 and the .38-40, this is primarily a rifle cartridge, for which revolvers were designed so that the user of a rifle of this caliber could also use the same ammunition in his six-shooter. In the old frontier days of black powder loads this was a highly practical idea. It meant that the ammunition supply was suitable for both the rifles and the handguns, and this was an item of importance to pioneers who might be located far from the nearest source of supply. However, with the advent of smokeless powders, it introduced complications, for the slow burning powders best suited to rifle use were not fast enough for revolvers. The result is that most of the .44-40 cartridges now on the market are



This is the chamber for the .44-40, (.44 Winchester) cartridge, and is used in the New Service and the Single Action Army revolvers. It was formerly used in the Bisley Model also.

loaded with a compromise type of powder, which does fairly well in both rifles and pistols, but not as well for either as certain other powders which are specially suited for either the rifle or the pistol, but not for both.

Even so, it is a powerful revolver cartridge, with its 200 grain bullet driven at 935 foot seconds, and giving 383 foot pounds of energy. Like the .38-40, it has a flat point, which increases the stopping power, and its large diameter also adds to its effectiveness. It is, however, inferior to the .44 Special and the .45 Colt in accuracy.

This cartridge was the original one for which the single action Colt, or "Peace Maker" was introduced in the far West in the old frontier days. For a time this idea proved very popular, and the .44-40 revolver was the standard large caliber gun in that part of the country. This popularity of the .44-40 suffered somewhat after the Army adopted the .45 caliber, as then everyone living near the Army posts wanted a .45 simply because the soldiers all had .45 caliber ammunition, and it became easier and cheaper to get.

But amongst plainsmen and prospectors the .44-40 "six gun" was standard equipment along with a Winchester rifle up until the coming of smokeless powder and more powerful, modern weapons.

The same caution applies to this cartridge as has been given in regard to the .32-20 and the .38-40—that is, the user should be careful to avoid the high-velocity or high-speed cartridges which are loaded to a high pressure and can not be used in revolvers without danger. In buying these cartridges for revolver use read the label on the box carefully. It will tell you if they are intended for rifles and revolvers, or for rifles only.

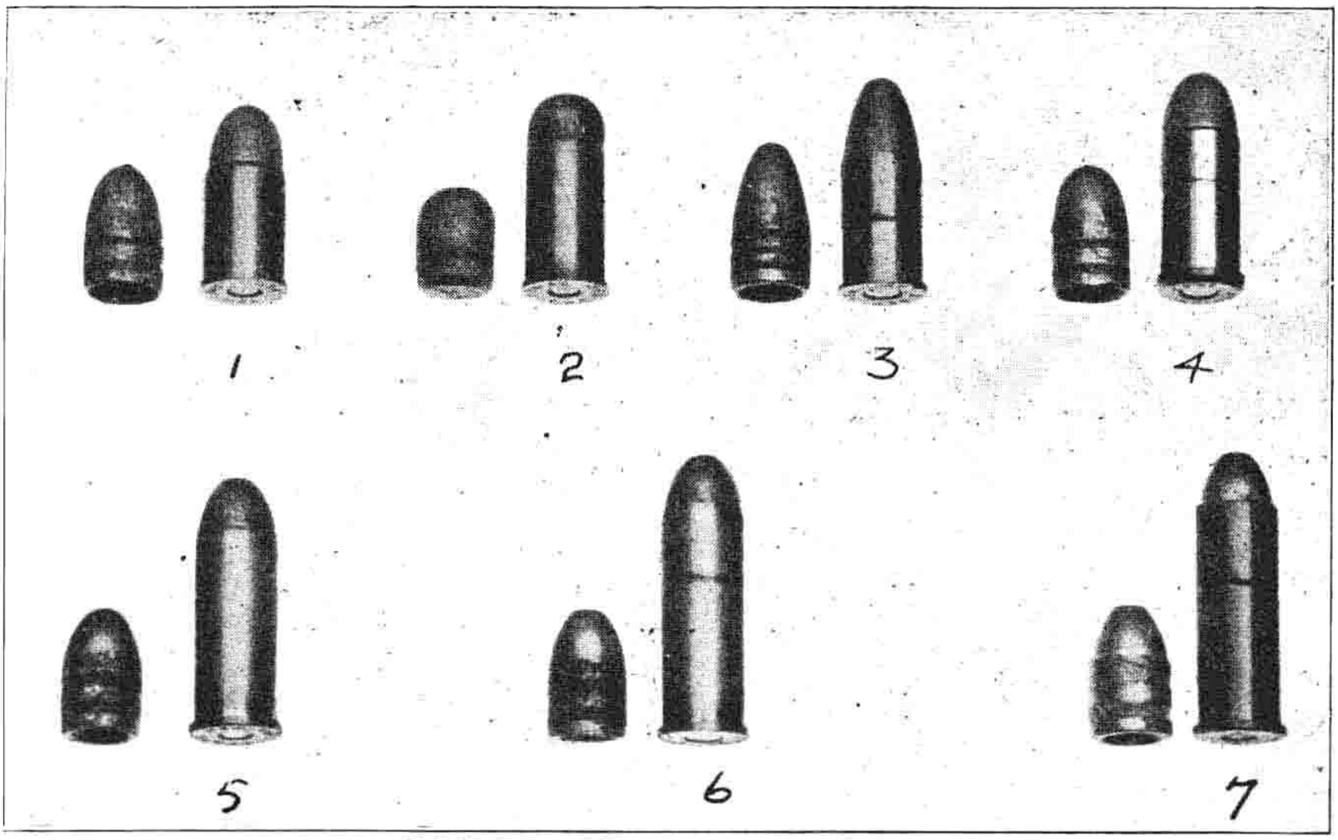
Bullet weight	200 grains
Bullet diameter	.426 inch
Bullet length	.59 "
Diameter cartridge head	.516 "
Diameter cartridge body, front	.441 "
Length case	1.31 "
Length loaded cartridge	1.60 "
Powder charge	16.8 grains Sharpshooter
Pressure	15,000 pounds per square inch
Muzzle velocity, 7½ inch barrel	935 feet per second
Energy	383 foot pounds
Penetration, ⅞ inch pine boards	7 boards

Reloading Data

Bullet name	Belding & Mull 425205	Metal cased	Lead
Bullet weight	195 grains	200 grains	200 grains
Powder, kind	Sport'g Rifle No. 80	Bullseye	King's S. S., FFG
Weight of charge	19.0 grains	7.0 grains	32 grains
Velocity	920 f.s.	920 f.s.	930 f.s.
Recommended by	DuPont	Hercules	King Powder Co.

.45 Smith & Wesson

This is another obsolete cartridge in the same category as the .44 American. It is an old black-powder cartridge designed for the .45 Schofield model Smith & Wesson Army revolver which followed the .44 American as an Army service weapon. It originally had a 230-grain lead bullet and was loaded with 28 grains of black powder, which gave 730 foot-seconds velocity.



.45-CALIBER REVOLVER CARTRIDGES

1. .450 Revolver, black
2. .45 Webley, black
3. .455 Webley, Mark II
4. .45/230 Auto-Rim
5. .45 Smith & Wesson
6. .45 Colt
7. .45 Government Model of 1909

After the Schofield Model Smith & Wesson revolver was in use the Army began to buy the Colt single-action arm, known as the "Peacemaker," and for many years both the Smith & Wesson and the Colt .45 were in service. The Government, therefore, continued to make the .45-caliber cartridge so it would fit both of these revolvers, and this cartridge that the Government made for so many years, though it was originally known as the .45 Smith & Wesson, afterwards became known as the .45 Colt Government, under which name it is listed in a recent Winchester catalogue.

The Ordnance Pamphlet on Army revolvers printed in 1898 gives the following data for this cartridge:

Accuracy

Deviations	*50 yds., inches*	*100 yds., inches*	*150 yds., inches*	*200 yds., inches*	*250 yds., inches*	*300 yds., inches*
Mean horizontal ..	4.2	3.8	7	9.8	20	19
Mean vertical	3.3	7.4	10.1	12.5	14.8	20.7
Mean absolute	5.3	8.3	12.3	15.9	24.9	28.7

The above results are the average of a limited number of targets of twelve shots each.

Recoil

Weight of revolver	*Weight of powder*	*Weight of ball*	*Recoil (theoretical)*
2.31 pounds	28 grains	230 grains	3.89 foot-pounds

Penetration in White Pine in Inches

Range	*50 yds.*	*100 yds.*	*150 yds.*	*200 yds.*	*250 yds.*	*300 yds.*
Inches	3¾	3½	3⅛	2¾	2½	2¼

As there is but one height of rear sight on this revolver—viz., that corresponding to 50 yards—the center of impact will fall lower and lower on the target as the range is increased. It will therefore be necessary in firing to raise the line of sight as much above the object as the trajectory passes below it. The following table gives the ordinates of points of the trajectory at 300 yards below the line of sight corresponding to 50 yards:

Ordinates of Trajectory Below Line of Sight.
Regular Sight: 50 Yards Elevation

Horizontal distance	*50 yds.*	*100 yds.*	*150 yds.*	*200 yds.*	*250 yds.*	*300 yds.*
Inches	0	16.2	48.6	99.9	165.1	256.4

This table is important, as it shows how far above one should aim in order to hit the object at the distances given. For instance, at 150 yards the point aimed at should be about 4 feet, and at 200 yards about 8 feet above the object.

All the early Colt and Smith & Wesson revolvers purchased by the Army were sighted for this cartridge (.45-230-28) and the front sight was adjusted in height for a 50-yard range. Many of these old Army Colt revolvers were later sold to the public through the disposition of Army obsolete stores, and many people ask why these guns always shoot about three inches high at twenty yards. The reason is that they were sighted in for this old Smith & Wesson cartridge and they are now being used with the regular .45 Colt cartridge (.45-255-38) which gives a greater jump, owing to the 25 grains additional bullet weight.

Most companies still load this old Smith & Wesson cartridge with the original 230-grain ball and 28 grains of black powder, but the Remington Company loads it with a 250-grain bullet which gives a somewhat reduced velocity of 710 foot-seconds.

Bullet diameter	.454 inch
Bullet weight	230 grains
Bullet length	.72 inch
Diameter of cartridge head	.521 "
Diameter of case, front	.475 "
Case length	1.10 "
Length of loaded cartridge	.143 "
Powder charge	28 grains FFG black
Velocity	735 f. s.
Energy	266 foot pounds
Remington bullet weight	250 grains
Remington black powder velocity	710 f.s.
Energy	280 foot pounds

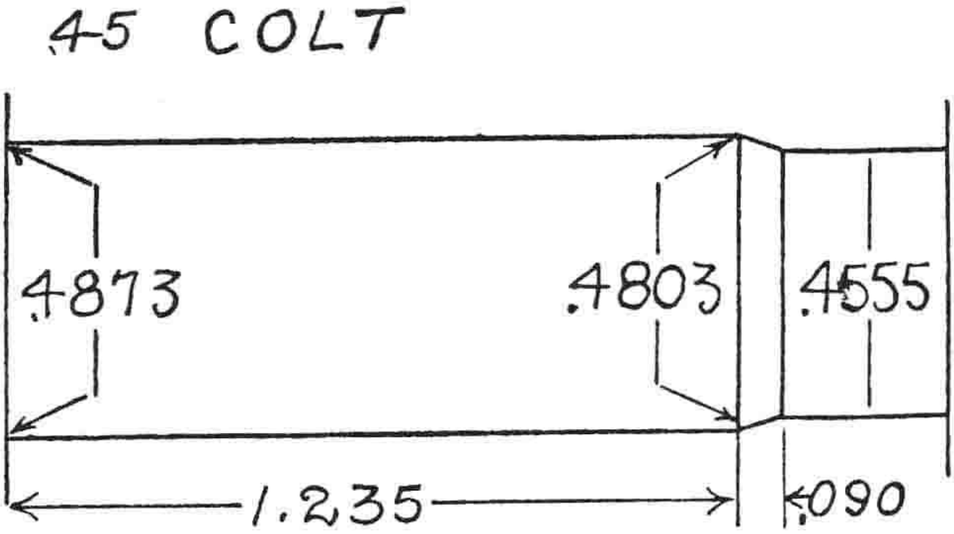
.45 Colt

This is one of the most famous and popular of all the .45-caliber cartridges. It is the old Peacemaker cartridge which had such a romantic history in the frontier days and is the cartridge with which most of the civilization of the West was accomplished.

The Colt New Service revolver and the Colt single-action revolver are now made for this cartridge. It has a 255-grain lead bullet with a muzzle velocity of about 770 foot-seconds and a muzzle energy of 330 foot-pounds.

This cartridge was originally loaded with 40 grains of black powder, which gave a higher velocity than the smokeless load gives. Cartridge companies now generally load the black-powder .45 Colt with around 34 grains of FFG Black, giving a little over 800 foot-seconds. However, the Remington Company uses a somewhat lighter bullet, 250 grains, and loads the full 40 grains of black powder behind it, giving a velocity of 910 foot-seconds and a muzzle energy of 460 foot-pounds, which is the highest muzzle energy of any revolver or pistol cartridge now sold.

Recently there has been much discussion and many lamentations from some of the old-timers out West who think that the Peacemaker has lost its wallop. They say that the .45-caliber Colt no longer has the punch that it had in the old frontier days. This, however, is not the true state of affairs as the present Remington load has more power behind it than any previous Peacemaker cartridge that has ever been put on the market. As a matter of fact, for years after the old Peacemaker was first introduced it was largely used with the .45-caliber Army cartridge which was the same as the old .45 Smith & Wesson and had a 230-grain bullet with 28 grains of black powder. However, at the time this gun was introduced by the Colt Company they also introduced the present .45 Colt cartridge, originally loaded with 40 grains of black powder.



The chamber for the .45 Colt Cartridge is now used in the New Service, the New Service Target, and the Single Action Army revolvers. It was formerly used in the Bisley Model.

The fact that the Army had in service two kinds of .45-caliber revolvers, one of which was the Smith & Wesson which would not take the long Colt cartridge, gave rise to two types of .45 cartridges which were commonly used in the Peacemaker, one the original type, with the 255-grain bullet, and one, the Army type, with the 230-grain bullet, still manufactured under the name of ".45 Smith & Wesson."

In 1892 the Army abandoned the use of the .45 and adopted the .38 double action, using the .38 Long Colt cartridge. However, in the Philippine campaign it was found that the .38 cartridge did not have sufficient stopping power and the Army, in 1909, adopted the Colt New Service double-action revolver in .45 caliber for use in the Philippines.

The .45 Model of 1909

This revolver was chambered for the regular .45 Colt cartridge, but Frankford Arsenal proceeded to manufacture a .45 cartridge for this gun which differed somewhat from the old .45 Colt. This cartridge was the same size, except for the rim which was made larger to give more bearing on the extractor. The cylinder of the Colt New Service revolver is larger than the cylinder of the Colt Single Action, and this larger rim could be used in the Colt New Service revolver, but a considerable amount of confusion was created when this revolver was made obsolete by the Army, for many of these .45-caliber cartridges were sold to civilian marksmen by the Government in disposing of obsolete stores, and it was found that when an attempt was made to use them in the .45 single action, trouble was encountered because the rims of the cartridges would interfere with each other when two cartridges were placed in adjacent chambers. Only every other chamber could be loaded. Except for this difference in the rim, the .45-caliber cartridge Model of 1909 is the same as the ordinary .45 Colt. It had a 255-grain bullet and was loaded with 8.4 grains of RSQ powder to a velocity of 738 foot-seconds. Because this was a Government cartridge careful tests were made which give a very good index as to the ballistic performance of the .45-caliber Colt cartridge at the long ranges. These figures, taken from Ordnance Pamphlet No. 1927, are as follows for the .45 Colt with 255-grain bullet and 8.4 grains RSQ smokeless:

ACCURACY WITH FIXED REST

Range, yards	*Mean radius, inches*	*Mean vertical deviation, inches*
25	1.058	0.692
50	2.042	1.724
75	2.61	1.681

NOTE: The above figures represent the mean variations for a great number of targets. Targets with 50 per cent less variations have been made.

VELOCITY, WITH STRIKING ENERGY

Range, yards	*Velocity, feet per second*	*Energy, foot-pounds*
0	738.0	297.3
25	687.4	257.85
50	651.3	231.48
75	617.8	208.28
100	585.7	187.2

VELOCITY WITH STRIKING ENERGY (Continued)

Range, yards	*Velocity, feet per second*	*Energy, foot-pounds*
125	555.4	168.33
150	526.5	151.27
175	499.0	135.88
200	473.1	121.25

PENETRATION IN WHITE PINE

Range, yards	*Depth, inches*
25	3.45
50	3.38
75	3.22
100	3.15
150	3.00
200	2.18

The penetration in moist loam at 25 yards is 19.2 inches. The penetration in dry sand at 25 yards is 8.28 inches.

This pamphlet also says that the maximum ordinate for the 200-yard range is 4.16 feet, and that a close approximation to the maximum ordinate for any range may be obtained by multiplying the square of the range in yards by .000144, the result being the approximate ordinate in feet.

Bullet weight	255 grains (except Remington 250 grains)
Bullet diameter	.454 inch
Bullet length	.72 inch
Diameter cartridge head	.508 " (.536 for Model of 1909)
" " body	.477 "
" " mouth	.476 "
Length case	1.28 "
Overall length	1.60 "
Thickness rim	.054 "
Factory smokeless load	5.7 grains Bullseye
Pressure	14,000 pounds per square inch
Velocity, 5½ inch barrel revolver	770 foot seconds
Energy	335 foot pounds
Penetration, ⅞ inch pine boards	5 boards
Remington black powder load	40 grains
Velocity in revolver	910 foot seconds
Energy	460 foot pounds

Reloading Data

Name of bullet	Ideal 454190	Ideal 454190	Winchester
Weight of bullet	255 grains	255 grains	255 grains
Name of powder	No. 80	Pistol No. 5	Bullseye
Weight of charge	12 grains	8 grains	5.0 grains
Velocity	785	870	784
Recommended by	DuPont	DuPont	Hercules

Metal-Jacketed .45 Caliber Revolver Cartridge

In 1906 some Colt .45 double-action revolvers were issued for use in the Philippines, and Frankford Arsenal made, for use in these revolvers, a special .45-caliber cartridge with a bullet weighing 234 grains with a cupronickel jacket. The charge was 6.9 grains of RSQ powder.

This cartridge will interchange with the .45 Colt and the .45 Model of 1909 described above. However, this is only of academic interest, as only a few of these cartridges were made and they are never seen today except in collections.

.45 Automatic Colt

This is the largest caliber automatic pistol cartridge and is the present service cartridge. It is a highly modern smokeless-powder rimless cartridge with a full-jacketed bullet weighing 230 grains. Because this is a Government service cartridge it has a great deal of information available on the ballistics that is not available for an ordinary commercial cartridge. The following information is taken from Training Regulations No. 320-15.

Accuracy With Muzzle Rest

Range, yards	*Mean radius, inches*	*Mean vertical deviation, inches*
25	0.855	0.619
50	1.356	0.910
75	2.244	1.422

The above figures represent the mean variations for several targets.

Velocity With Striking Energy

Range, yards	*Velocity, feet per second*	*Energy, foot-pounds*
0	802	329
25	788	317
50	773	305
75	758	294
100	744	283
125	730	272
150	717	262
175	704	253
200	691	244
225	678	235
250	666	226

PENETRATION IN WHITE PINE

Range, yards	*Depth, inches*
25	6.0
50	5.8
75	5.6
100	5.5
150	5.2
200	4.6
250	4.0

The penetration in moist loam at 25 yards is 9.95 inches. Penetration in dry sand at 25 yards is 7.8 inches.

The following table of angles of departure for the .45 A.C.P. Cartridge with 230 grain bullet and muzzle velocity of 800 feet per second may prove interesting.

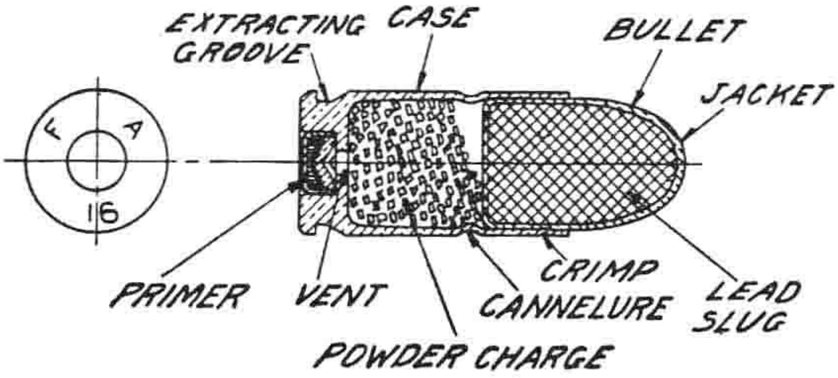
Range	*Angle of departure*	
100 yards	0 degrees	19.2 minutes
200 "	0 "	44.7 "
300 "	1 "	14.2 "
400 "	1 "	50 "
500 "	2 "	34.7 "
600 "	3 "	26.3 "
700 "	4 "	27.5 "
800 "	5 "	33.5 "
900 "	6 "	47 "
1000 "	8 "	15.3 "
1100 "	9 "	55 "
1200 "	12 "	1 "
1300 "	14 "	50.5 "
1400 "	19 "	2 "

The maximum range is approximately 1600 yards at an angle of elevation of 30 degrees. The maximum ordinate, or greatest height of the 1600 yard trajectory is 2000 feet.

The accuracy figures given for this cartridge have been greatly improved since the tests quoted above. In the accuracy test at Sea Girt in 1919 the average mean radius at 50 yards was 1.81 inches and the average group diameter 5.59 inches. At the tests made at Sea Girt in 1920 for the acceptance of National Match ammunition the average mean radius at 50 yards was 1.14 inches and the average group diameter was 3.83 inches.

After this date a considerable amount of attention was given to the question of obtaining increased accuracy with the .45-caliber automatic ammunition, and changes were made in the diameter of the bullet and the dimensions of the barrel. The diameter of the bullet was changed from the old standard of .4505 to the present standard of .4515, and the standard bore diameter of the pistol was changed from .445 plus or minus .001, to .443 plus .001, minus nothing. A considerable increase in accuracy was at once apparent, the average mean radius of daily tests in May, 1924, at Frankford being .77, the average group diameter 1.92. Further improvement in accuracy was made as the result of certain changes in the jacket metal, and in 1925 an average of five targets fired in a daily test gave a group diameter of 1.75 at 50 yards. Groups of less than one inch at 50 yards are frequently obtained.

Formerly there were two distinct types of .45 Automatic cartridge; the Government standard, described above, loaded with a 230 grain bullet and a muzzle velocity of 810 feet per second, and the commercial type, loaded with a 200 grain bullet and a muzzle velocity of 910 feet per second. The muzzle energy of the Government type is 340 foot pounds, and that of the commercial type is 368 foot pounds. The manufacture of the 200 grain type has been discontinued.

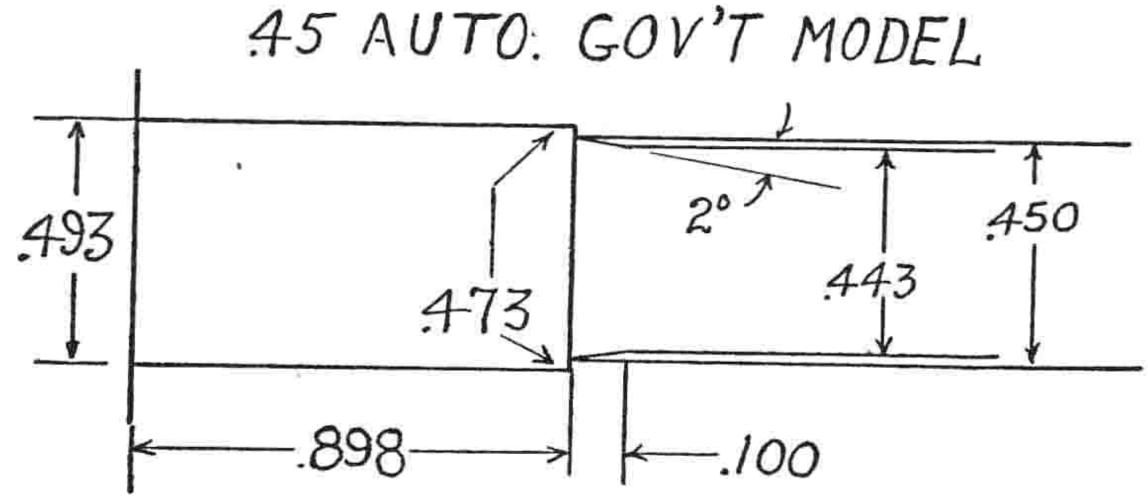


Caliber .45 Auto-Colt Pistol Cartridge.

A jacketed bullet generally does not have as great stopping power as a lead bullet and tends to glance more easily, and for that reason the .45 Automatic is not as effective as the .45 Colt, but it has a powerful knockdown blow and has been found highly satisfactory for military use.

Besides being used in the Automatic Pistol, this cartridge is used in the Model of 1917 Colt and Smith & Wesson Revolvers. When used in these revolvers it will not extract unless a special steel clip is used, which fits around the heads of the cartridges, which are of the rimless type. Without the clip the cartridges can be used in the revolvers but must be pushed out with a stick or lifted out with the rim of another cartridge after firing.

The .45 Automatic differs from the old .45 Colt in that it was originally designed for smokeless powder, and therefore the space in the shell was made only large enough to accommodate the proper charge. Thus there is no excess airspace, and the smokeless powder burns well and very efficiently. The .45 Colt, on the other hand, has a much larger case, originally intended to hold a large charge of black powder. When the dense smokeless powders came into use, it was found that the space in these cases, intended to hold 40 grains of black powder, were too large to work most efficiently with the small charges of perhaps 7 grains of smokeless. This is why the .45 Automatic, which appears to be much smaller than the .45 Colt, is nearly as powerful.



Standard Chamber Dimensions of Colt .45 Automatic Pistols.

Many interesting experiments have been performed on the .45 Automatic Cartridge. For example, it was found that with a lot of Bullseye Powder which required 4.4 grains for a normal charge to give 800 f.s., a charge of 12 grains failed to burst an automatic pistol, though the head of the cartridge was blown out and the slide of the gun was bulged. However, fifteen grains split the barrel and blew out the side of the frame.

A charge of 1 grain of Bullseye drove the bullet halfway through the barrel; 1½ grains drove it 50 feet beyound the muzzle; 2 grains drove it into a sand butt 50 yards away, while 2½ grains functioned the mechanism.

Bullet weight	230 grains
Bullet diameter	.4515 inch
Bullet length	.662 "
Diameter of cartridge head	.471 "
Diameter of cartridge mouth	.471 "
Case length	.90 "
Length loaded cartridge	1.26 "
Factory charge, Bullseye	4.9 grains Bullseye powder
Pressure	14.170 lbs. per square inch
Velocity	821 foot seconds

Factory charge, Pistol No. 5	6.1 grains No. 5
Pressure	13,990 lbs. per square inch
Velocity	824 feet per second

Reloading Data

Name of bullet	Ideal 452374	Belding & Mull 452236	Factory made
Weight of bullet	220 grains	238 grains	230
Kind of powder	Pistol No. 5	No. 80	Bullseye
Weight of charge	5.6 grains	7.5 grains	4.6 grains
Velocity	880 f.s.	775	800 f.s.
Recommended by	DuPont	DuPont	Hercules

.45 Auto-Rim

After the war there were many thousands of Colt and Smith & Wesson Army revolvers, Model of 1917, sold to the public by the Government, and Smith & Wesson still manufacture and sell this model. This arm is chambered for the .45 Automatic Pistol cartridge, and it was intended that this cartridge should be used with a clip because it is a rimless cartridge and otherwise will not extract from revolvers. Just after the war the Peters Cartridge Company started to manufacture a cartridge specially designed for these Model of 1917 revolvers.

This cartridge is similar to the Automatic Pistol cartridge except that it has a rim. It is called the ".45 Auto-Rim." The Remington Arms Company soon followed suit and also manufactured the auto-rim cartridge. With the metal-jacketed bullet the auto-rim cartridge duplicates the ballistics of the .45 Automatic Pistol cartridge. However, this cartridge is now made also with a plain lead bullet.

The Auto-Rim lead cartridge made by the Peters Cartridge Company has a 255-grain bullet and gives ballistics very similar to those of the old .45 Colt.

Owing to the shape of the inside of the base, the .45 Auto-Rim cartridge has slightly more powder space than the .45 automatic.

Name	.45 Auto-rim, lead bullet
Bullet weight	.255 grains
Bullet diameter	.451 inch
Bullet length	.74 "
Diameter cartridge head	.512 "
Diameter case, rear	.475 "
Diameter case, mouth, outside	.472 "
Length case	.90 "
Length cartridge loaded	1.27 "
Thickness rim	.087 "
Muzzle velocity	740 feet per second
Energy	310 foot pounds

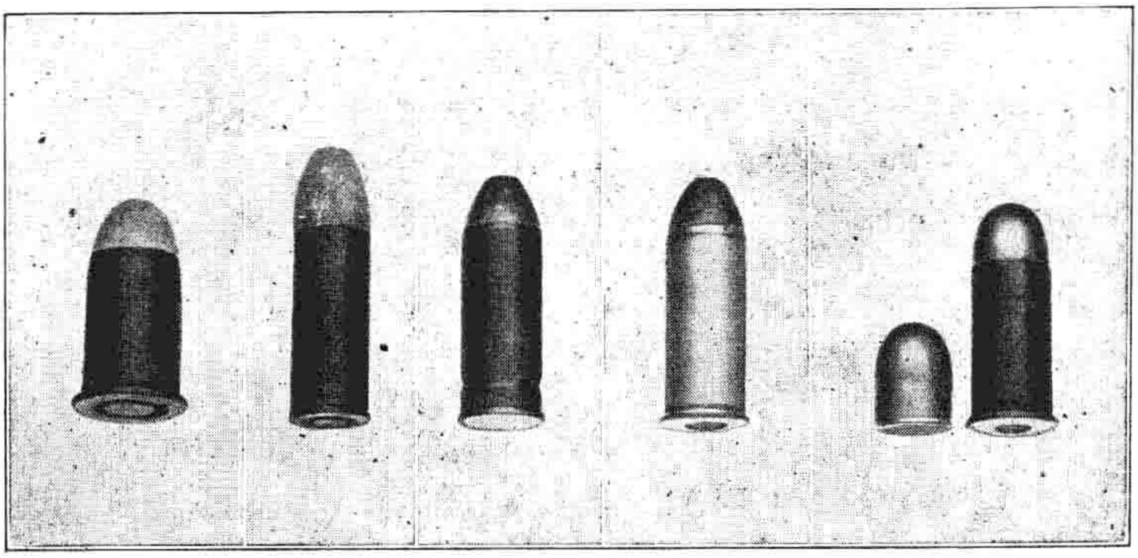
Name	.45 Auto-rim, jacketed bullet
Bullet weight	230 grains
Bullet dimensions	Same as for .45 A. C. P.
Case dimensions	Same as for .45 Auto-rim lead bullet
Powder charge	4.5 grains Bullseye
Pressure	14,000 pounds per square inch
Muzzle velocity	810 f.s.
Energy	340 foot pounds

Reloading Data

Name of bullet	Belding & Mull 452236	Belding & Mull 452236
Weight of bullet	236 grains	236 grains
Name of powder	Bullseye	Pistol No. 5
Weight of charge	4.0 grains	4.9 grains
Velocity	800 f.s.	780 f.s.

.450 Revolver

This is a black powder cartridge for foreign revolvers of that caliber. While it is not often seen in this country a few are manufactured to take care of the occasional demand. The sample described has a hollow base bullet.



OLD-TIME CARTRIDGES IN THE AUTHOR'S COLLECTION

1. .50 Remington Navy.
2. .44 "Martin" cartridge made at Frankford Arsenal, 1871.
3. .45 cartridge made at Frankford Arsenal, 1878. Inside primer (central-fire) 28 grains powder and 230-grain bullet.
4. .45 cartridge made at Frankford Arsenal, 1891. 28 grains powder and 230-grain bullet.
5. .45 cartridge with metal jacketed bullet made at Frankford Arsenal in 1906.

Bullet weight	226 grains
Bullet diameter	.458 inch
Bullet length	.75 "
Diameter of cartridge head	.503 "
Diameter of cartridge body	.476 "
Length of case	.69 "
Length of cartridge	1.09 "
Powder charge	13 grains black
Muzzle velocity, 6 inch barrel	590 f.s.
Muzzle energy	170 ft. lbs.

.45 Webley

This is an English cartridge of moderate power that is largely used in target practice. It is manufactured in this country to supply the occasional demand.

Bullet weight	230 grains
Bullet diameter	.450 inch
Bullet length	.61 "
Diameter of cartridge head	.504 "
Diameter of cartridge body	.471 "
Length of case	.82 "
Length of cartridge	1.15 "
Muzzle velocity, 6½ inch barrel	550 f.s.
Muzzle energy	150 ft. lbs.

.455 Webley

This is the service revolver cartridge of the British Army. It follows the British idea of obtaining the maximum stopping power by means of a heavy bullet moving at low velocity. It has a heavy, conical bullet with a rather long, slender point with a weight of 255 grains. The powder space in the cartridge is very small.

Bullet weight	265 grains
Bullet diameter	.457 inch
Bullet length	.88 "
Diameter of cartridge head	.528 "
Diameter of cartridge body	.475 "
Length of case	.77 "
Length of cartridge	1.23 "
Powder charge	7 grains smokeless
Muzzle velocity, 6½ inch barrel	600 f.s.
Muzzle energy	220 ft. lbs.

Name	.455 Webley man-stopper
Bullet weight	220 grains
Bullet diameter	.455 inch
Bullet length	.72 "
Length of cartridge	1.11 "
Other dimensions	Same as .455 Webley

.455 Webley Self Loading Pistol

This cartridge is not made in America, but is interesting because it is the service cartridge of the British Royal Navy. It has a 220 grain, full jacketed bullet and a charge of seven grains of Cordite, giving a standard velocity of 750 foot-seconds.

The cartridge is very similar in appearance to the .45 Automatic Colt. The main differences are that the cartridge is of the semi-rim instead of the rimless type and the bullet is nearly flat on the point instead of being conical. The Colt bullet has an advantage of five grains in weight, but the Webley bullet is superior in stopping power on account of the very flat point.

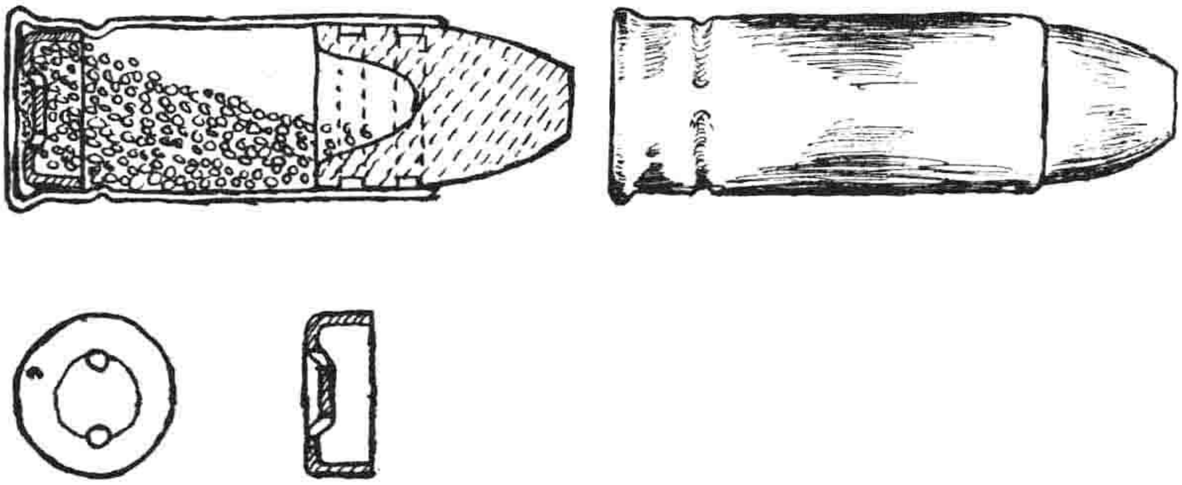
Bullet weight	220 grains
Bullet diameter	.455 inch
Bullet length	.59 "
Diameter of cartridge head	.500 "
Diameter of cartridge body	.474 "
Length of case	.93 "
Length of cartridge	1.23 "
Powder charge	7 grains cordite
Muzzle velocity, 5 inch barrel	750 f.s.
Muzzle energy	270 ft. lbs.

.476 Eley

The only cartridges of this type that I have ever seen were those tried by the United States Government Board of Officers in 1904 when a bullet with more stopping power was found necessary for use in the Philippine Islands. This bullet was found to have more stopping power than any other bullet tried by the Board. It was tested in a Colt New Service revolver chambered specially for it. The bullet has a hollow base containing a clay plug which expands it into the rifling.

The data given below are taken from cartridges in the author's possession which were part of the lot originally obtained for the Board mentioned above.

Bullet weight	288 grains
Bullet diameter	.474 inch
Bullet length	.90 "
Diameter of cartridge head	.508 "
Diameter of cartridge body	.478 "
Length of case	.88 "
Length of cartridge	1.48 "
Powder charge	18 grains black



Old "Inside Primer" .45 Colt. Center fire Cartridge made at Frankford Arsenal in 1874. From the Author's collection. Box marked "12 Cartridges, for Colt's Revolver, Cal. .45. Powder, 30 grains. Bullet, 250 grains. Frankford Arsenal, February, 1874."

CHAPTER 11

TECHNICAL NOTES ON AMMUNITION

THE many uncertainties connected with nearly every phase of the manufacture, use, or study of ammunition are what make the subject so interesting. In making any ordinary mechanical object, such as, say, a knife or a wrench, the maker has only to use the correct material and make the material into the shape indicated on the drawing. If measurements show that he has done this, he knows that his production will be satisfactory, and will work as expected.

With ammunition, on the other hand, every precaution may be taken to make everything exactly to specifications, and the closest inspection may reveal that the product is as nearly perfect as the most delicate weighing and measuring instruments can detect, yet when the cartridge samples go on the testing range, the accuracy may be poor; and all the skill of the best engineers may be unable to detect the reason for the trouble. Again, another lot of ammunition made under exactly the same conditions may give superb accuracy.

Such small troubles as these are negligible, however, when compared to the feelings of the cartridge maker when a lot of ammunition that has been giving satisfaction in the hands of the shooters suddenly begins to go bad on the shelves of the dealers and in the hands of the public, as actually happened a year or so after the first introduction of the non-corrosive priming compound. One of the ingredients was subject to deterioration under conditions of storage in warm and humid places, and when this deterioration occurred, misfires and hang fires resulted, and the accuracy of the ammunition became very poor.

It is occurrences like this which discourage the cartridge maker from trying new things. Once he has a product which has stood the test of time in the hands of the shooting public, he feels safer to stick to it, even at the risk of being called non-progressive.

Even a time tried product may go bad when the conditions of manufacture are changed. The Government Non-Mecuric Primer which had been made at Frankford for years suddenly went bad and spoiled a large quantity of ammunition just at the beginning of the World War. There was not time to stop making ammunition and investigate the cause of the trouble so that the Ordnance Department took the drastic step of abandoning the standard primer formula and buying the needed primers from the commercial cartridge companies while they installed the process of making primers according to the formula of the Winchester Repeating Arms Company. It was later found that the cause of the trouble was the very speed with which ammunition had to be made. The haste to get large production made it necessary to rush the drying of the primers by artificial heat, and this caused the mixture to sour. This expression brings to mind the operation of making bread, and it is a fact that making an excellent lot of ammunition is something like making a cake; even when everything is done according to directions and experience, the result is better some times than at others.

Cartridge Life

Many times I have been asked how long cartridges will last; whether or not they will get stale; whether or not the powder will deteriorate so that they will get dangerous. The life of well made metallic small arms ammunition is perhaps ten years on the average. Some ammunition may lose some of its strength in five or six years, and other lots may last twenty years or more. Something depends on the conditions of storage. Damp, warm climates are the worst, but even there, the cartridges should last at least several years.

There is very little trouble from the deterioration of the modern smokeless powders. They have very much the same composition as celluloid, and will last just about as long, or longer. They do not deteriorate as fast as many common materials, such as silk, rubber, etc. And it is fortunate that when deterioration does take place, it always weakens the powder. There is no danger of the powder's getting stronger, so as to burst the gun. The only exceptions that need be made to this statement are to state that under different storage conditions, such as the presence or absence of steam heat, etc., the powder may absorb moisture or dry out slightly. When it dries, it will become moderately stronger until such time as it absorbs moisture again. Powder makers and cartridge companies endeavor to make their test firings for determination of charges with the powder having a moisture content that is about the average to be expected under conditions of storage and use. The changes from this cause are not serious, under any conditions. The other exception is in the case of black powder, which may become caked from moisture, so as to give high pressures.

Primer deterioration is unlikely with any well tried primer composition, though at times of radical change in methods, such as the introduction of the non-corrosive primer, which occurred several years ago, troubles may occur.

Occasionally cartridge cases will crack while in storage. This is due to a well known characteristic of brass, which has a tendency to separate or crack if it is strained from severe working and then allowed to stand without relieving the strains by heating. In the case of the small arms cartridge, it is not possible to anneal the metal and relieve the strains without making it so soft as to weaken it at the base of the cartridge and around the primer pocket, where the brass must be very strong and springy. A certain amount of annealing is done to relieve the strains and prevent season cracking, but the manufacturer is always working between the danger of over annealing and thus having blown primers and other troubles, or of under annealing, with the risk of having the ammunition split after a few years of storage.

Mercury and its compounds have the quality of causing brass to split very quickly if it is in a strained condition. In the cartridge factories a very weak solution of mercuric chloride, (corrosive sublimate), or mercurous nitrate is used as a test to see if the cartridges have a tendency to crack. A cartridge dipped in this solution will crack in a few seconds unless the brass is properly annealed.

For the reason that mercury is "poison" to brass, the early non-corrosive primers ruined the cartridges so that they could not be used for reloading. This was because the non-corrosive primer composition contained mercuric fulminate, a salt of mercury. During the explosion, mercury is deposited all over the inside of the case. The amount is small, but it is ample to make the cases too brittle for further use. Fortunately, the later non-corrosive mixtures are made without the mercury in most cases.

Cartridges will go bad very quickly if oil gets inside the case, for it will make the primer insensitive, and thus cause misfires, or if it does not reach the primer, it may cause the powder to burn slowly, so that the velocity is reduced. Many burst revolver barrels have been caused by the fact that oil, or grease from the bullet lubricant, has mixed with the powder to such an extent that the bullet would go only partway through the barrel. If the user fails to notice this trouble and fires another shot, the barrel will be bulged or burst.

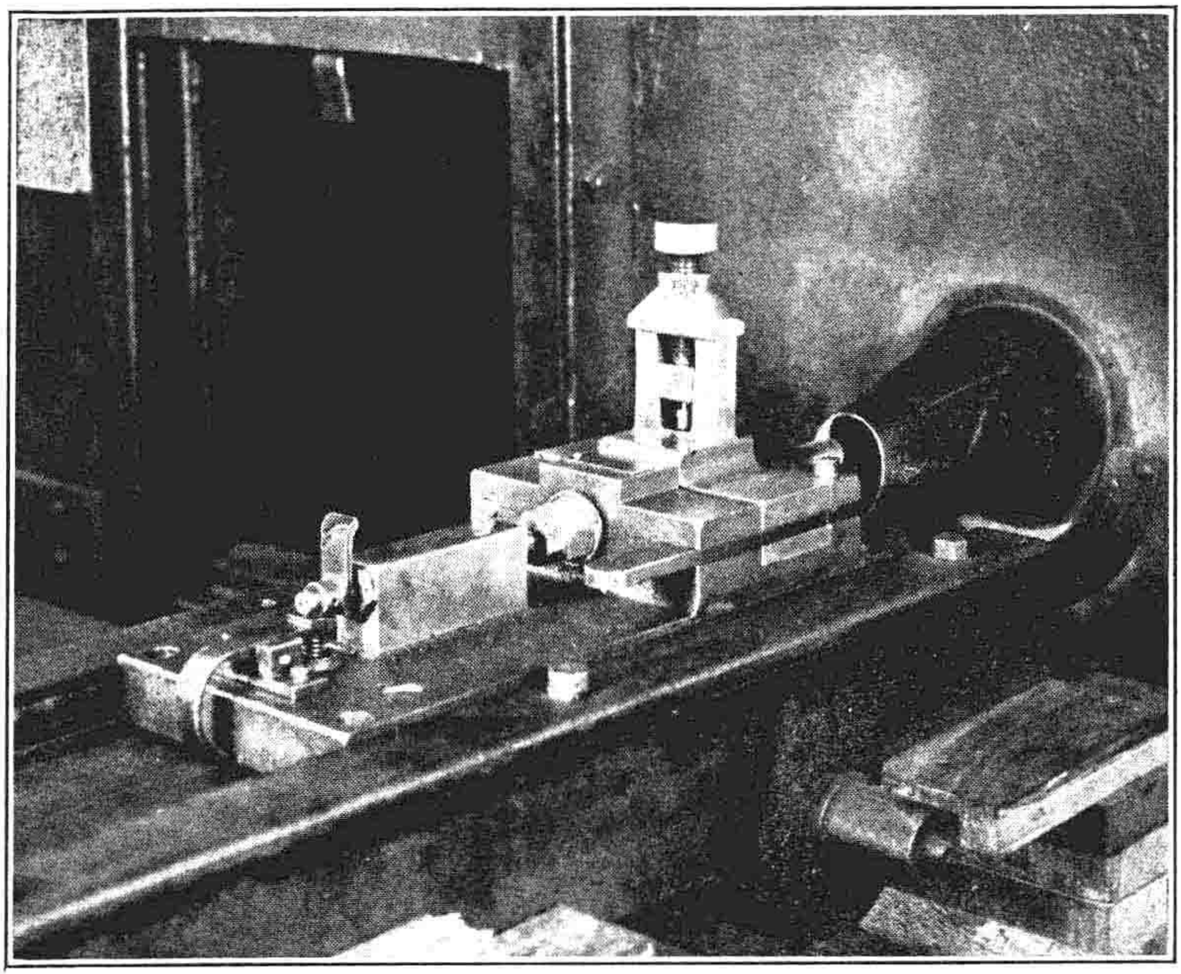
In order to prevent the entrance of oil or moisture, it is common practice to varnish the mouth of the case before the insertion of the bullet, and to put a ring of waterproofing around the joint between the primer and the primer pocket. At the present time a substance much used for this purpose is what is called N.R.C. Compound. The name comes from "National Research Council," as the composition was developed by that body.

On account of the danger of misfires caused by oil on the cartridges, it is not a good thing for the peace officer or other gun user to keep his loaded revolver reeking with oil. On the other hand, when loading a gun it is desirable to wipe the cartridges over with a rag which has been moistened with the smallest possible quantity of oil, so as to leave an imperceptible film of oiliness on the surface. This will prevent the cartridges from corroding in the cylinder of a revolver if they should be left there for a long time.

Pressures

When any cartridge is fired, a very high pressure results inside the gun from the sudden explosion. In cartridge factories, constant tests are made of each day's production to insure that no cartridges are sent out that have a pressure so high as to be dangerous. The test is made by the use of a pressure gun. This consists of a gun with a hole bored into the chamber from the top. A piston with a copper cup on the end to prevent the escape of gas is fitted into the hole, and a copper cylinder is fitted on top of the piston, and held in place by a strong steel yoke. When the gun is fired, the gas pressure pushes upward on the piston, and this upward push crushes the copper cylinder. A number of exactly similar copper cylinders have previously been subjected to known amounts of weight, and the crushing that resulted from each weight has been entered onto a sheet called a tarage table. When the pressure gun is fired, the copper cylinder is taken out and measured with a micrometer caliper, and the resulting length is compared with the tarage table. The table shows what weight had to be applied to the copper to crush it that much.

In high-powered rifles, the pressures run as high as about 50,000 pounds per square inch, but in revolvers and pistols, it is usually not over about 15,000 pounds per square inch, and in most of them it is around 9,000 or 10,000 pounds per square inch. Exceptions are the Luger and Mauser cartridges, with pressures of 24,000 and 30,000 pounds per square inch respectively, and the Super .38 Automatic, with about 25,000 pounds per square inch.



A pressure gage for pistol cartridges. Inside the rectangular block near the funnel is a barrel chambered for the .45 automatic pistol cartridge. On top is a heavy yoke for holding a copper crusher cylinder on a steel piston communicating with the interior of the barrel. When the explosion takes place, the gas pressure, acting through the piston, compresses the copper cylinder, and the amount of this compression is afterwards measured to give the pressure. At the rear is seen the simple firing mechanism.

There are several factors which affect the pressure that a cartridge may give. The most obvious one is the amount of the charge; naturally, the more powder, the more pressure. Other factors which also have a bearing on the pressure are, the bullet weight, the bullet diameter, the air space in the cartridge case, and the temperature.

In general, for charges in the vicinity of the normal load, the pressure changes very uniformly with changes in the powder charge; but when a point is reached where all the air space in the cartridge is used up, or even with plenty of air space, when the pressures reach a certain point, small increases in charge may result in sudden and dangerous increases in pressure. This is why it is not advisable to experiment blindly with smokeless powder.

As an example of the changes that may be expected, take the case of the .45 Automatic Pistol Cartridge. With lot 101 Bull's-eye Powder, 5.1 grains were needed to obtain full velocity. A tenth of a grain more or less raised or lowered the velocity 20 feet per second, and raised or lowered the pressure 700 pounds per square inch. With Pistol Powder No. 5, lot 88, a charge of 6.0 grains gave the proper velocity, and a tenth of a grain more or less raised or lowered the velocity 15 feet per second and the pressure 700 pounds per square inch.

Hot weather raises the temperature, and cold weather lowers it. However, the changes in pressure in pistol cartridges due to weather changes are never sufficient to make any practical difference to the shooter. As an indication of how much the velocity and the pressure may be expected to change with high temperatures, the following tests are of great interest. A number of cartridges for the .45 automatic pistol were loaded with bull's-eye powder, and subjected to a temperature of 100 degrees Centigrade, (212 degrees F.), and were fired for velocity and pressure while they were at this temperature. The cartridges were retained at the high temperature for one hour before firing. The results follow:

Condition	*Velocity*	*Mean Pressure*
Normal cartridges not heated	830 f.s.	15,100 lbs.
Cartridges heated to 100°C	880 f.s.	16,600 "
Difference	50 f.s.	1,500 "

In another test, the cartridges, loaded with 4.9 grains of Bull's-eye, were frozen to 22 degrees below zero, F., and then fired. There was a loss of 32 f. s. in velocity and 2,600 pounds pressure. In another test, the ammunition was cooled to 79 degrees below zero, Centigrade, (110 degrees below zero F.) and fired at that temperature. A lot of cartridges loaded with 4.6 grains Pistol Powder No. 6 lost 41 feet in velocity, and 1,620 pounds pressure. A lot loaded with 4.7 grains Bull's-eye lost 56 feet velocity and 2,440 pounds pressure. A lot loaded with 5.8 grains of Pistol Powder No. 5 lost 111 feet velocity and 4,740 pounds pressure.

The high velocity tests did develop the fact that sometimes when nitro-glycerine powders are subjected to very high temperatures, some of the nitro-glycerine may be stewed out, and it may get into the primers and cause misfires. Otherwise, high temperatures do not seem to change ammunition that has been heated and then cooled again.

In making these tests, some of the ammunition was subjected to temperatures as high as 120 degrees centigrade, which is 248 degrees F. At this temperature several of the cartridges exploded from the heat. When left at this temperature 48 hours, 4 out of 5 exploded. When left at this temperature 8 hours, none exploded, but at 16 hours, 1 out of five, and at 18½ hours, 3 out of five had exploded. The explosions seemed weak, so that a loaded gun was subjected to the same temperature. The bullets on either side of the barrel did not clear the cylinder, being stopped by the frame. The bullet which was in line with the barrel passed out, but did not penetrate the side of the oven, which was made of two thicknesses of .035 galvanized steel. There was no damage to the weapon. Quite evidently where the powder is ignited very gradually in this manner, the explosion is extremely weak, and in no manner compares with the results when the powder is ignited all at once, as is the case when a primer flashes into the charge.

Conclusions from these tests are:

1. Caliber .45 cartridges, loaded with nitro-cellulose or nitro-glycerine powders, when subjected to temperatures in the order of the boiling point, for varying times up to 72 hours, after cooling to normal temperatures, may be fired with normal velocities and pressures.
2. Caliber .45 cartridges, loaded with nitro-glycerine powders, when subjected to temperatures ranging between 40 degrees C. (104 degrees F.) and 140 degrees C., (248 degrees F.) are subject to misfires, which increase in number generally with an increase in the temperature or the time during which they are subjected to high temperature. These misfires are due to the penetration of the primer, and its deadening by products of decomposition of the powder.

The three rifle cartridges that are used in revolvers—namely, .32-20, .38-40 and .44-40—are all old-timers. They were originally made with black powder for use in both the Winchester rifles and the Colt revolvers. As the years went by and rifle cartridges became improved these three cartridges were considered to be too low in velocity for modern conditions. As powders were improved the ammunition companies found they could increase the velocities of these old cartridges by using some of the later powders, and the result is what is known as the "high-velocity" type. In these the pressure runs way above what it did in the original cartridges, and they should never be used in revolvers. Many accidents have been caused by ignorance of this fact on the part of owners of revolvers of these calibers who would naturally just ask for the .38-40 cartridge, or whatever caliber they wanted, and take whatever the hardware dealer gave them. If this happened to be the improved high-velocity type they were in danger of bursting the cylinder of their revolvers. These high-velocity cartridges are marked on the box, "Not adapted to use in revolvers," but this caution is not always read. Of late years the cylinders of revolvers have been specially heat-treated to minimize the danger of accidents from this cause, but even if you have a late revolver with a heat-treated cylinder it is not advisable to use this high-pressure ammunition, it is a bit too strenuous for any handgun.

Velocity

Pistol and revolver bullets usually have velocities of around 800 feet per second. There are some, however, which have higher velocities, such as the Super .38 Automatic, with its velocity of 1200 feet per second, and the .30 Caliber Mauser, regularly listed at 1375 feet, which often runs above 1400. I personally tested a lot of wartime .30 Mauser cartridges brought from Germany after the war, which gave an average of 1425 feet per second.

Recently there has been a big increase in the standard velocities of a number of the more popular pistol cartridges. Notable is the case of the .22 long rifle, which in 1930 appeared in the Hi-Speed and Super X types, giving velocities of 1300 and 1400 feet per second respectively in rifles, and up to 1100 feet per second in revolvers. The attainment of these high velocities was naturally accompanied by an increase in pressure, and the fear that this might result in burst heads in the .22, with the consequent escape of gas and possible injury to the shooter led to a recommendation by the makers of the first of these high velocity .22s against their use in pistols or revolvers, or indeed, in anything except the very highest grade bolt action rifle. Shortly after these new cartridges appeared on the market, Major Douglas B. Wesson, of Smith & Wesson produced his K-.22 revolver, built especially for the Remington Hi-Speed cartridge. As a matter of protection in case of burst cartridge heads, or rather to keep them from bursting, the chambers of this gun are counterbored at the rear end so that the head of the cartridge can sink in flush with the surface. This idea was immediately followed by all the other makers of revolvers, and the high speed cartridges came into use in both revolvers and pistols.

Recently Major Wesson produced a .38 caliber revolver on the frame of the famous .44 Military. This gave a heavy gun, with a thick barrel and cylinder. In view of the additional strength and weight in this gun, it was thought that it would be advisable to make the .38 Special cartridge with higher velocity than standard especially for use in this heavy frame gun. This new cartridge has 1125 foot seconds velocity as against the standard velocity of 860 foot seconds. This new cartridge came out under the name of the .38-44. The .38 Colt Special, which is the same as the .38 Smith & Wesson Special with a blunt pointed bullet is also loaded to 1125 feet per second for use in this heavy frame gun, under the name of .38 Colt Special High Velocity. The regular .38 Special low velocity cartridges can of course, be shot in the .38-44 Outdoorsman's Revolver. The high velocity loads can also be shot in the regular .38 Military and Police or the Colt Official Police .38 if desired, but the recoil is rather heavy. Other heavy frame revolvers made in the .38 Special Caliber for which the .34-44 and .38 S. & W. Special High Velocity and .38 Colt Special High Velocity cartridges are especially suited are the Colt New Service, the Colt Shooting Master, and the Colt Single Action.

This recent tendency toward high velocities in revolver cartridges is further exemplified by the fact that for several years the Remington Arms Co. have made it a regular practice to load the .45 Colt cartridge with black powder to a considerably higher velocity than the 770 feet per second which has been the standard smokeless velocity for some years. The velocity of this Remington Black Powder load is 910 f. s. Recently the Western Cartridge Company changed their smokeless .45 from 770 f. s. to 910 f. s.

Range of Pistol Bullets

While the range at which the ordinary pistol and revolvers are supposed to be effective is only 50 or 75 yards, all of them will send their bullets much further than that, and are capable of inflicting fatal wounds at distances up to one mile, depending on the caliber.

Thus the .32 Automatic Colt Pistol, when discharged at an elevation of 26 degrees, will send its bullet over 1300 yards, and the .25 caliber elevated at an angle of 15 degrees will shoot 850 yards.

The dispersion at these ranges is very great, and it would be difficult to hit an object the size of a large house, but stray shots discharged in the air may do serious damage a long way off. I know of a case where a boy was killed at a distance of 639 yards by a .22 short.

Moreover, bullets will bounce off many objects, and go in unexpected directions. A bullet fired so that it strikes the ground at a slight angle will usually bounce up at nearly the same angle, and continue its flight with plenty of speed remaining. Frequently an officer of the law has fired on the ground to frighten a fleeing person, and then has been surprised to see the fugitive fall. How many times have we seen in the papers that a boy who had been discovered in an orchard or melon patch was killed when the owner fired a shot on the ground "to frighten them."

A bullet fired straight up into the air would come back with the same velocity that it had when it started if it were not for the air resistance; but in practice, a bullet fired straight upward has little velocity remaining when it returns to earth. If you feel that you must fire a loaded gun to frighten someone, fire it straight down into the ground, so that it will not bounce, or straight up into the air.

Accuracy

The ordinary outdoor range for pistol-shooting is 50 yards in length, though some years ago the Army had a qualification course that went up to 75 yards.

Owing to the short sighting radius of a pistol or revolver, it is difficult to get accurate results offhand at distances greater than about 75 yards, though a good shot can place most of his bullets in an object the size of an ordinary barrel at a distance of 200 yards.

There is really not much known about the relative accuracy of different pistols and revolvers and their cartridges because it is so hard to get really satisfactory mechanical tests which will eliminate the human error of holding and pulling the trigger. In testing cartridges, it is difficult also to eliminate the variation in different guns, even of the same make, and in testing guns it is difficult to eliminate variations in ammunition. Therefore, for a long time all we had on the accuracy of pistols and revolvers and their ammunition was a sort of tradition, built up by a mass of accumulated experience of shooters with different types of arms. This information was, of course, far from exact and was often complicated and confusing. If a man happened to have a particularly good .44 revolver, for example, he would declare that the .44-caliber was the most accurate in the world. If, on a certain day, he happened to be holding particularly well, the make of ammunition he was using that day was probably considered by him to be the best make. The only indisputable facts that were developed in this way were that the .22-caliber Long Rifle and the .38 Smith & Wesson Special had extraordinarily good accuracy.

For a long time the author tabulated various opinions on this subject from well-known shots, and it was found that there was a very great variation between these authorities, but they all agreed in placing the .22 and the .38 Special ahead.

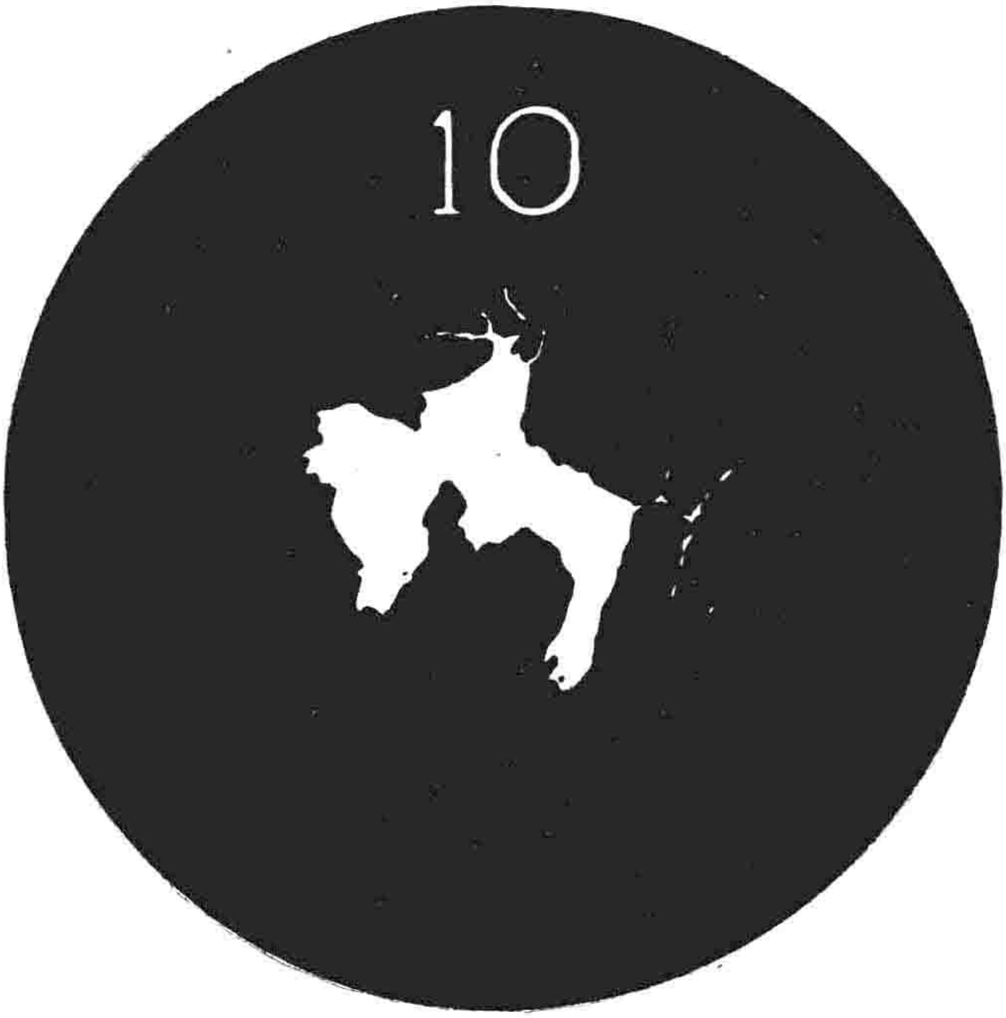
The following tabulation shows the relative accuracy of the different revolver cartridges fired by a good marksman from a muzzle rest. Such a rest eliminates most of the errors of holding, but still require the gun to be sighted by eye, so that the errors of eyesight remain. The range at which the firing was done was 50 yards in all cases. I consider these figures a reliable indication of the relative accuracy of the various cartridges.

AVERAGE GROUP DIAMETERS OF REVOLVER CARTRIDGES ACCORDING TO CHAUNCEY THOMAS; A. L. WOODWORTH, BALLISTIC ENGINEER OF SPRINGFIELD ARMORY; AND A. C. HULBERT, FORMERLY OF COLT'S PATENT FIRE ARMS COMPANY.

Cartridge	*Figures of Mr. Thomas*	*Figures of Mr. Woodworth*	*Figures of Mr. Hulbert*
.22 Long Rifle	1 in. to 2 in.	1 in. to 2½ in.	1 in. to 2½ in.
.32/20	2 in. to 3 in.		3 in. to 4 in.
.38 Special	2 in. to 3 in.	2 in. to 3½ in.	1½ in. to 2½ in.
.38/40	4 in. to 5 in.		3½ in. to 4 in.
.44 Special	3 in. to 4 in.	3 in. to 4 in.	2½ in. to 4 in.
.44/40	4 in. to 5 in.		3⅛ in. to 4 in.
.45 Colt	5 in. to 6 in.	4 in. to 5½ in.	2¼ in. to 4 in.

Many attempts were made to develop a machine rest for testing pistols, but it was found that when the arm was clamped in a machine rest, the recoil would gradually cause the group to spread, so that this method of testing did not get us anywhere. For a long time Frankford Arsenal, in testing the automatic pistol cartridges, used a short heavy barrel the same length as a pistol barrel screwed onto a Springfield rifle receiver and stock. Later on a special Mann barrel was developed for this test, consisting of a heavy barrel the same length as a pistol barrel, mounted on two concentric rings and sliding in a V block. With this apparatus all variables were eliminated except relative accuracy of the ammunition, and after this machine was developed the accuracy of the Frankford Arsenal .45-caliber pistol ammunition was rapidly improved.

In a test held at Sea Girt in 1919 to select ammunition for use in the National Matches, the average group diameter of the Frankford Arsenal Pistol Ammunition at 50 yards was 3.83 inches. In the daily tests at Frankford Arsenal in May, 1924, the group diameters averaged 1.92. An average of five targets fired in the daily tests in February, 1925, at Frankford Arsenal gave an average group diameter of 1.75 inches at 50 yards. Groups of less than 1 inch at 50 yards were frequently seen. One group noticed in making these tests was of such a size that all the shots would have touched a dime, the extreme group diameter being about three-fourths of an inch, but this, of course, was an exception. At the



An actual machine-rest target reproduced exact size of a 50-yard group made at Frankford Arsenal with .45-caliber, 1925 National Match Automatic Pistol Ammunition. Made on 50-yard Standard American target.

present time it is thought that the .45-caliber ammunition manufactured by the Government Arsenal at Frankford is, on the average, the most accurate pistol cartridge made.

Col. Jones, of the Springfield Revolver Club, constructed a pair of rings to clamp onto the barrel of the Smith & Wesson Single Shot Pistol, and with this device he obtained groups of around 1 inch at 50 yards with the .22 Long rifle cartridge. He made similar rings for different revolvers, and with the .22-32 revolver, using the .22 Long rifle cartridge, he reported groups of 1½ inches at 50 yards. With the larger revolvers, the rings clamped onto the barrel and frame did not work well, as there was too much jump.

Harrington and Richardson constructed a satisfactory machine rest into which a .22 caliber single shot pistol can be clamped. This rest worked very well indeed, and was of inestimable benefit in helping H. & R. to make their single shot pistols and Sportsman revolvers extremely accurate.

Major Douglas B. Wesson constructed a machine rest with which he was able to test the K-.22 Revolver and the Straight Line pistol. This rest has been most useful and satisfactory. However, both the H. & R. and the S. & W. machine rests will not work so well for any caliber larger than the .22.

Methods of Measuring Accuracy

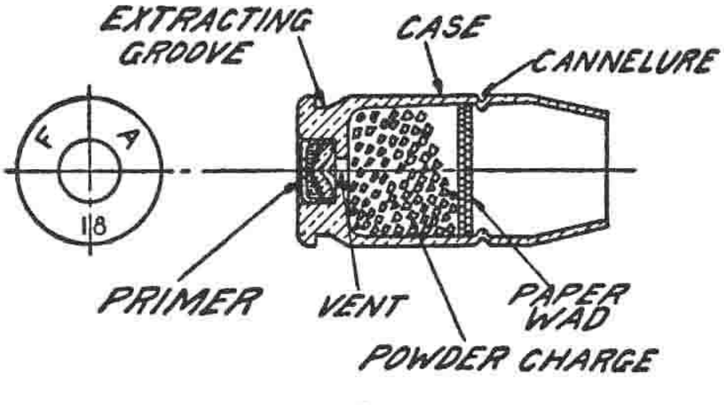
While we are on the subject of accuracy, it is in order to say a word or two about the different methods of naming or describing the accuracy of a group of shot holes. The most practical way from the point of view of the user of a pistol is to measure the group diameter—that is, the actual size in inches of the group of shots. However, the Government has for years used a different system in measuring rifle accuracy, and this system makes use of what is known as the "mean radius."

First, the average center of the shot group is determined. Then the distance of each shot from this center is measured and all these distances are averaged up. Thus, the average distance of all the shots from the center of the group is obtained and this is known as the "mean radius." It is generally about one-third the size of the group diameter in inches. In other words, a group with a mean radius of 1 inch will probably have an over-all diameter of 3 inches or thereabout, though this varies, of course, with the characteristics of the group. The method of measuring a target to obtain the mean radius is to draw a horizontal line through the bottom shot hole and a vertical line through the left-hand shot hole. Then the vertical distance of each of the shots in the group from this horizontal line is measured, and the average taken and this gives the height of the center of the group. The horizontal distance of each shot from the vertical line is then taken, and the average gives the horizontal location of the center of the group.

These two figures used in arriving at the vertical and horizontal positions of the shot group are called the "mean vertical" and the "mean horizontal" deviations and will be found in ordnance pamphlets describing the accuracy of ammunition. It has been found that the mean-radius system is not a very good one when very small groups are encountered because it is difficult to distinguish the shots. For this reason, in measuring small groups, the Ordnance Department has adopted a system called the "figure of merit." The maximum horizontal width of the group and the maximum vertical width are measured and averaged, and this average is the figure of merit, which is very close to the group diameter.

Blank Cartridges

Blank cartridges are made in most revolver calibers. They are loaded with an extremely quick powder which does not require the pressure of a bullet to make it go off with a bang. This powder is called "EC Blank Cartridge Powder," the letters "EC" standing for "Explosives Company," the English firm that first made this powder. It consists of virtually all guncotton, mixed with some adhesive substance, such as gum water or very thin mucilage and made into little grains by the adhesiveness of the binder. It is, therefore, extremely rapid in its action and can not be used for loading any kind of ammunition that has a bullet, as the pressure would be too high. This is a little confusing, because there is an-



CAL. 45 BLANK CARTRIDGE MODEL 1918.

other "EC" powder that is used for shotgun shells, and in two cases I have known the owners of shotguns to reload shells, using the EC Blank powder instead of the EC Shotgun powder, and in both instances this has resulted in the destruction of the gun with extreme danger to the user.

Blank cartridges should never be fired directly at any person because they all have a cardboard wad, and little pieces of the cardboard will fly for ten or fifteen feet and may pierce the skin. This would be particularly disastrous if one of these pieces should strike the eyes. Many cases of lockjaw have resulted from Fourth of July celebrations with blank cartridges in which they were fired directly at people at short range. The little pieces of cardboard being blown into the skin with violence usually carry germs with them.

Blank cartridges are not generally used with automatic pistols because they will not operate the mechanism satisfactorily; but recently some that will do this have been designed. They are made in Belgium for the pocket size automatics, and they have a bullet made of some paper composition which breaks up when the gun is fired. The bullet is hollow and is filled with powder. The powder charge is very large and fills, not only the whole cartridge case, but also the hollow paper bullet. This powder inside the bullet is what causes it to break up in small fragments. The powder used in these Belgian cartridges is not the EC Blank, but another kind.

At one time the Springfield Armory experimented extensively to make a blank firing attachment for the .45 automatic pistol. In this a special barrel was used with a choke screwed into the front of it and the chamber so shaped that an ordinary ball cartridge could not get in by accident. The device was only fairly satisfactory and has been discontinued.

Bullets

There are many different varieties and kinds and shapes of bullets used in modern ammunition. The earliest lead bullets were simply round balls, but the modern bullets are almost without exception elongated, and the most of them are rounded or pointed on the front end.

The pointed shape gives an advantage when it comes to getting through the air easily, but it is not quite so good when it comes to target shooting at short ranges as is a square shape. The pointed bullet goes through the target paper in such a manner that the resultant hole is much smaller than the bullet, and it is often difficult to tell just where the edge is. As the shot counts the next higher value if the edge touches the next ring, it is very convenient in scoring to be able to see plainly just where the edge comes on the target. In order to accomplish this, bullets with the front square instead of pointed are often used. These are called "wad-cutter" bullets.

Wad-cutters may be obtained in factory loads for the popular .38 Special cartridge, but if the target shot wants to use them for other calibers, he will usually have to purchase a bullet mould or some bullets of that type from one of the makers of reloading supplies, and load his own.

In 1934, the Remington Arms Company introduced a high speed .22 caliber long rifle cartridge with a wad-cutter bullet, called the Sharp-shoulder bullet. It is recommended for target practice up to 50 yards in rifles only, as it does not always feed perfectly in automatic pistols, and sometimes fails to pattern correctly in revolvers. In my experience with it, I have found that it shoots beautifully in single shot pistols.

Wad cutter or flat pointed bullets give more stopping power than round nosed ones. For that reason the .32 Smith & Wesson Long, the .38 Smith & Wesson, and the .38 Special are duplicated in cartridges called respectively, the .32 and .38 Colt New Police, and the .38 Colt Special, which have a rounded point with a flat end to it. These bullets are more effective in stopping power and ability to disable than the corresponding round nosed ones.

The .22 Caliber, .32-20, .38-40, and the .44-40 cartridges are made with bullets having a hollow point. Such bullets are also sometimes called "Express" bullets. When fired with rifle velocities, they tend to open up at the point, and make a much more deadly wound. However, when fired with pistol velocities against flesh, they fail to open or expand, and are of about the same effectiveness as plain lead bullets with a flat point, such as the regular .32-20, etc.

Jacketed Bullets

Most revolver bullets are made of plain lead alloy, with no hard covering. However, cartridges for automatic pistols usually have the bullets covered with a jacket of a harder metal, very often gilding metal, (90 parts copper, 10 parts zinc), or cupro-nickel (60 parts copper, 40 parts nickel), or in Europe and other foreign countries, steel coated with copper or cupro-nickel. Lubaloy, (from "lubricating alloy") the jacket material used by Western Cartridge Company, is similar in composition to gilding metal, with the addition of a small percentage of tin. Nobeloy, used by Nobel in Great Britain is understood to be practically the same thing.

This is done in the case of automatic pistols to prevent the bullets from becoming marred in feeding from the magazine. Bullets for high velocity rifle cartridges must be jacketed to keep the lead from melting from the intense heat of the powder gases under high pressure and the friction of passing through the barrel at high speed.

A jacketed bullet with the lead uncovered at the point of the bullet is called a soft-point bullet. When fired from a high velocity rifle, such a bullet will expand on striking flesh until it looks like a mushroom, hence they are often called mushroom bullets. Some times they are called Dum-dum bullets, from the fact that bullets intended to expand on striking were once produced at the British Government Arsenal at Dum-dum in India. Such bullets are of little more effect than a full jacketed bullet in revolvers or automatic pistols, because the velocity is too low to cause the bullet to expand.

Lead bullets must be lubricated, else the friction of the passage through the barrel will cause the metal to solder itself to the steel of the barrel in lumps or layers that will interfere seriously with the accuracy. This action is called "leading." Most lead bullets are what is called inside lubricated; that is, there are several grooves around the bullet inside the neck of the cartridge, and these grooves are filled with a lubricating grease or wax.

In the old days, however, the grease was put on the outside of the bullet. Generally the bullet was made the same size as the outside of the cartridge case, and the rear end, or heel, of the bullet was reduced in diameter so as to fit into the inside of the cartridge neck. Then the part of the bullet that projected outside of the case was dipped into melted lubricant, or had grooves around it filled with lubricant. Thus the grease was exposed, and whenever the cartridge was handled, grease would get smeared around. If the cartridge should be dropped, dirt or sand would adhere to it. Thus the outside lubricated bullet was messy and inconvenient, and has nearly been superseded for center fire cartridges, as all modern cartridges are inside lubricated, and the only outside lubricated ones now made are those whose design is old. However, one of the most popular cartridges of all comes in this class, and this is the .22 long rifle.

In order to make a cartridge of this kind that will be clean and convenient to handle, many expedients have been tried. One is to plate the bullet with a thin layer of copper or lubaloy. This does not rub off as easily as lead, and the danger of leading is thus reduced. Another way is to plate the bullets with cadmium. Remington puts out such a bullet under the name of Silvadry. These dry bullets are very convenient, but when fired rapidly in automatic pistols or other repeating arms, they will often cause bad leading. Moreover, they are not to be recommended for target matches, because the user never knows when the leading may start, and thus give him a poor score.

Recently the Peters Cartridge Company has placed on the market a .22 with an invisible lubrication called "Filmkote" which seems to do very well. The author has not examined any of these cartridges closely, and has not been told how they are made, but if required to hazard a supposition as to what it is, would as a first try at it say that it is very likely similar to the lubrication that J. D. Pedersen, the eminent gun designer used on the cartridges for his semi-automatic rifle. This consisted of a mineral wax dissolved in carbon tetrachloride (which is the same thing as Carbona or Pyrene). The cartridges were dipped in the solution, and when they dried, a thin film of wax was left on the metal. This was so hard that it would not pick up dirt, and could not be noticed in handling, but it provided sufficient lubrication for the purpose.

Cartridge Case Material

Center fire cartridge cases are today practically always made of brass. Rim fire cases are usually made of copper, but lately the advent of the Hi-Speed .22 brought with it a brass case for these particular cartridges, though the others are still made of copper. Cartridge cases of either brass or copper may be tinned or nickeled and thus may look like some other metal. Many of the old black powder cartridges had a white case, which was simply a brass case tinned.

It is useful to know that it is a common practice to make the modern smokeless cartridges with an indented ring or cannelure around the case, to give a ready means of telling them from the black powder loads, which are in plain cases with no ring around.

CHAPTER 12

BULLET EFFECT AND SHOCK POWER

BECAUSE pistols and revolvers exist primarily for personal defense, everyone who depends on them at any time for his safety should be interested in knowing just how effective a shot will be in instantly rendering an adversary incapable of further aggression.

Almost any pistol or revolver, of whatever caliber it may be, is fully capable of inflicting a fatal wound; but many of the smaller and less powerful hand firearms do not possess stopping power; that is, the ability to put an adversary out of the fight instantly, even though the blow may not be in a vital spot. There are pistols with which a man may be fatally wounded and yet not feel it at the time, whereas there are others with which he may be practically paralyzed for the time being, though he may afterward recover.

If the time ever comes when it is necessary to use a pistol to save your life, you do not want an arm that will merely enrage your adversary; you want one that will put him down and out at once.

A very good illustration of the lack of stopping power which characterizes some of the smaller calibers was furnished several years ago in one of our Eastern cities when a member of the police force was called on to kill an old stag in the park who had outlived his usefulness. The officer placed the muzzle of his .32-caliber revolver a few inches from the deer's head, and shot him near the base of the horns. The old fellow shook his head a couple of times, as though a fly had bitten him and he wanted to scratch the place; and then he went on eating grass. After awhile a rifle was found and he was killed, but the revolver shot had apparently not inconvenienced him at all. Of course, he could have been killed with the revolver if he had been shot somewhere else besides the thick part of the skull; but even if he had been shot in this manner with a .45 he would have been knocked flat.

This shows very well how useless this small-caliber arm would be to a hunter as an auxiliary to his rifle. If any large beast charged him and he shot it with this gun he would be gored or trampled to death before the wounded animal found out that it was hurt.

I have had a very clear illustration of this lack of shock power on the part of the .32-caliber revolver because I was once shot with one of these arms at a distance of about two feet. I was looking right into the muzzle of the gun and saw a number of bright sparks coming out of the muzzle apparently right into my face, and at the same time I felt a slight sensation of numbness in my right arm; and though the bullet had passed through the third finger of my right hand, through the handle of the revolver which I held and embedded itself into my wrist, it did not inconvenience me in the slightest nor put my arm out of action. There was no pain whatever, only a slight numbness, and later I washed my hand merely because the wound was bleeding slightly and walked some distance to a doctor's office and had the bullet taken out.

If the gun with which I had been shot had been a .45 instead of a .32, it would not only have paralyzed my right arm but would have passed entirely through my wrist and entered my body, inflicting a fatal wound.

The gun with the greatest shock power is not necessarily the most fatal one, however. A gun which delivers a very heavy paralyzing blow may simply knock a man out for a while and he may then recover, while a bullet of smaller caliber which lacks shock power may penetrate to a vital part of the body, such as the intestines, and cause a wound which is not felt at the time but which will cause death several days later.

It is a peculiar fact that the .22 caliber, while almost entirely lacking in shock power, is one of the most fatal cartridges. I knew a doctor out in a small Mexican border town where I was once stationed that said he was most afraid of a .22-caliber gun because he performed more autopsies on people killed with .22-caliber arms than with any other kind. He said he had seen lots of shooting with the jacketed .45's and that the victims frequently recovered. One reason is that the small outside lubricated .22-caliber bullet is a great carrier of germs which set up blood poison, and these little lead bullets usually lodge in the body, where they remain to start the infection, while the clean jacketed bullets of the automatic pistols do not easily carry dirt and, moreover, they frequently pass entirely through the body.

I once knew of a case of a boy who was shot with a .22 short at a distance of 639 yards—nearly half a mile—and he died the next day. The bullet pierced his abdomen. The stopping power in this case was negligible. The boy was not knocked off his feet, or made unconscious, but he was fatally hurt.

A case that is exactly the reverse of this happened in a small border town where I was stationed many years ago. Smuggling of arms had been going on, and a River guard was after a certain gun-runner and traced him to a certain saloon. The River guard entered with his Army automatic in his hand, and as he did so both he and the gun-runner fired at each other simultaneously. The heavy lead bullet from the gun smuggler's .45 Colt struck the River guard in the chest and passed completely through him. The two shots that the River guard fired both struck the gun smuggler in the head, the first striking him near the top of the forehead and the second in the mouth.

Both men went down in a heap, and when the doctor was called he said it was a case for the undertaker, not for the doctor; that they were not dead but would be in a few minutes. However, neither one of these men died. The smuggler was hit once in the forehead with a .45 Automatic bullet which glanced on his sloping forehead and passed around under the scalp. The other bullet entered his mouth and lodged in the solid mass of bone at the base of the skull; and he made a prompt recovery in about three weeks. The River guard was more seriously injured, the bullet having passed through his lung, but he recovered in about six weeks. In this case the stopping power was perfect; both men were put out of action instantly. But neither was fatally hurt. So it should be clearly understood that stopping power is not necessarily the same thing as killing power.

And while the .22 was described above as lacking in stopping power, it should also be borne in mind that this refers to shots which do not strike a vital spot. There are some parts of the body, such as the brain, where all shots, of whatever caliber or power, are practically equal. A young man shot himself in the head with a .22 which pierced the skull and traversed part of the brain. He became unconscious instantly and was pronounced dead in three minutes. A .45 would have had no more stopping power in this case.

There has always been much speculation as to just how a bullet delivers shock, and as to just which qualities are the important ones in this regard. This question has been the subject of much experiment and investigation, but at the present writing it is still unsolved. Some of the important qualities of any bullet as regards stopping power are:

1. Its weight.
2. Its velocity.
3. Its energy, which depends on the weight and velocity.
4. Its diameter, or caliber.
5. The shape of its point.
6. Its balance and gyro-static stability.

Effect of Bullet Weight

Obviously mere weight is of no account without velocity. Even a cannon ball will not hurt you when it is standing still. On the other hand, velocity will not be of any effect without weight to carry it through. Recently I read an article written in Europe in which the stopping power of bullets was said to be entirely independent of the weight of the bullet, but to depend only on the diameter of the bullet and its velocity.

The fact that this view of the matter is not the correct one may readily be realized by considering the difference between being struck by a .45 caliber pistol bullet weighing 230 grains, and moving at a velocity of 810 f. s., and being struck by a paper target paster of the same diameter moving at the same speed. A large animal would be stopped by the .45 caliber bullet; but he would not even notice the paper disc. Another illustration of the same thing is the difference between being struck by a paddle and a sledge hammer. The paddle has a very wide surface, and a relatively high velocity, but it lacks weight, and its effects are expended on the surface. It stings, but does not cause much injury. On the other hand, the sledge hammer has less velocity, but it has weight to carry the velocity through, and it will cause a deep and serious injury.

The statement is often seen in some of the older ordnance manuals describing the various weapons that a penetration of one inch in pine corresponds to a dangerous wound. However, penetration is not the only criterion, as is indicated by the following statement of a board of officers in considering a divided pistol bullet intended to increase the likelihood of hitting, as given in the report of the Chief of Ordnance in 1890: "It is generally considered that a dangerous wound from a small arm would be caused by a penetration corresponding to one inch in white pine; but this is dependent upon the supposition that a shock to the whole system is also given and which requires for its fulfillment some considerable weight in the projectile. The revolver bullet weighs 230 grains, and it is not likely that a ball of materially less weight would have a dangerous effect if capable of penetrating only an inch in pine. These fragments weigh about 55 grains, and their average penetration at 10 yards is but very slightly more than half an inch, and at 20 yards only a quarter of an inch. It would therefore appear as if a hit, even if made, could have but very little if any effect, certainly not immediately, and would be entirely unavailing to stop a bayonet charge and still more useless against advancing cavalry."

Effect of Bullet Velocity

But if we will suppose that the bullets under consideration all have a reasonable amount of energy and weight, what then is the relative effect of velocity on stopping power? Is it better to obtain your energy by means of a light weight and a high velocity, or a heavy weight and a slow velocity? Take a .38 Super Police bullet, weighing 200 grains, and having 725 f. s. velocity. It will have about 232 foot pounds of energy. The regular 158 grain .38 Special would have the same energy with a velocity of 815 f. s. Which would be better?

The answer, as far as it can be given from the experimental work that has been done to date is that there is little difference whether the energy is obtained higher velocity and lower weight, or the reverse. In other words, in the range of velocities common in pistols and revolvers, that is about from 500 foot seconds to 1200 foot seconds, mere velocity itself seems to be of little moment. In connection with rifle bullets we hear a lot about the explosive effects of high velocities; and it is true that such effects are observed when the bullet strikes cavities filled with fluid; but these explosive effects do not take place until velocities well above 2000 feet per second are reached, and this is way above the range of velocities under discussion. Velocity seems to have relatively small effect on stopping power with pistols or revolvers, as long as the bullet does not strike bone. When bones are struck, however, the resultant damage is much greater with bullets having velocities of 1200 feet or the like, than with those in the neighborhood of 750 or 800 feet per second.

Right here it is only fair to say that the opinion is widely held that low velocities are actually more effective than high velocities for pistol bullets. The following is quoted from the British Text Book of Small Arms, 1929: "The value of the caliber of self-loading pistols and revolvers has been much obscured by theory, but the practice of recent years has amply proved that small caliber plus high velocity, although developing many foot pounds of energy, yet lacks stopping or shocking value. There have been many attempts to substitute a high velocity cartridge of .38 caliber, as a Service equivalent to the traditional .455. In practice it has been found that the small caliber sometimes fails to stop its man, and that the large diameter leaden plug of the .455, moving even 300 or 400 feet a second slower than the high-velocity, small caliber projectile, is yet far more effective. Recent experiment has, however, developed a new experimental .38 cartridge whose efficiency is, so far as ballistic tests can ascertain, not less than that of the .455 (Note—this cartridge resembles the .38 S. & W. Super Police in size, bullet weight, and ballistics—Author). A hit with a .455 anywhere literally knocks an adversary over. The quality of efficiency depends to some extent on the massive soft lead bullet and the relatively low velocity rather than on any inherent magic in the caliber, for the .455 or .45 self-loading pistol firing a lighter nickel covered bullet at a higher velocity cannot be depended on to produce equal shock effect. The efficiency of the .455 revolver cartridge is due to the combination of the large caliber with the soft material, the mass, and the relatively low velocity of the projectile. These combine so that the adversary experiences in his body the maximum of shocking as distinct from penetrative effect. This is just what is wanted in an active service revolver."

It seems difficult to believe that the low velocity adds anything to the effect. The author believes that the reason that large, low velocity bullets show satisfactory effectiveness, is that the low velocity allows the use of a large bullet, rather than that there is any inherent virtue in the low velocity itself. It is of course true that with very brittle materials, like glass, low velocities produce quite different effect from high velocities, and may cause more damage, as is seen when a bullet passes through a window pane and leaves a relatively small hole, whereas the entire pane is shattered by a rock tossed with relatively low velocity; but this is a very special case, which depends on the peculiar brittleness of glass, which cannot be penetrated at all, but fails always by breaking.

There is also more or less talk of the victim being "literally bowled over" by large and heavy bullets going at low speeds; and of their having knock-down rather than wounding power. It is true that the power of any bullet to put motion into its victim, so as to tend to knock him over depends more on the weight of the bullet than on the energy, and that a slow heavy bullet will communicate more motion to the victim than will a fast small one with more energy; but calculations and tests show that the actual push delivered by any bullet is too small to account for the knocking down of the victim. In fact, experience shows that men who are shot have a strong tendency to fall *toward* the gun.

When a bullet is entirely stopped in the body of the person shot, its power of giving him motion is measured by the bullet weight times the velocity, or the momentum, and is equal to the energy of the bullet divided by the velocity, (since energy is proportional to weight times velocity squared). Numerically, the motion given to an object when a bullet stops in the object is equal to the velocity of the bullet multiplied by the weight of the bullet, divided by the combined weights of the bullet and the object.

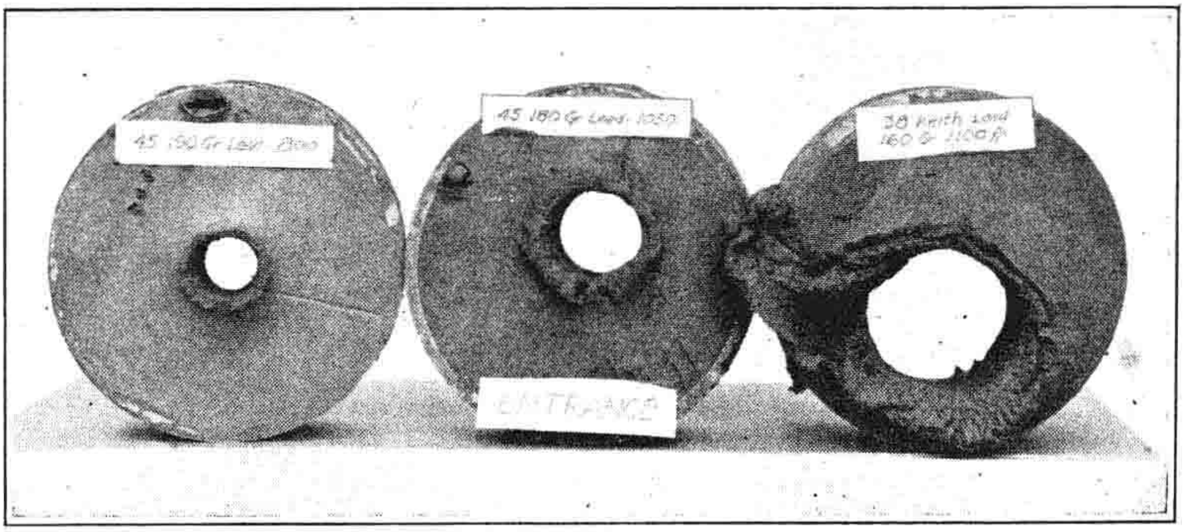
Thus suppose that the .45 automatic pistol bullet, weighing 230 grains, or 1/33rd of a pound, and moving at 800 f. s., should strike a man weighing 150 pounds, and stop inside him. The velocity that he would acquire would be 800 x 1/33 divided by 180.03. This works out to about one seventh of a foot per second. When it is realized that a man walking moves about seven feet per second, or nearly fifty times as fast, it will be seen that the actual motion impressed on a man when he is struck by a bullet is insignificant, and that he is never "literally bowled over" by a pistol bullet. The reason for this may be more clearly seen when it is considered how very quickly a bullet stops when it hits. The push that it gives does not have time to transmit any great amount of velocity, because it lasts such a short time. Consider what would happen if you threw a baseball against a heavy safe door that happened to be standing open. It would not move. Even if you threw your whole weight suddenly against the heavy safe door, it would hardly move. To shut it, you have to apply a push for a considerable interval of time. In striking a heavy body like a man, the bullet does not have time to put it into motion.

Quite another thing, however, is the nervous and muscular reflex set up by the impact of the bullet. It may cause the victim to move violently, to leap into the air, or to fall. It does not, however, depend on the bullet weight, but rather on the damage or shock transmitted to certain nervous centers.

But even if it does not knock the victim over, the heavy large caliber bullet is the one that is generally credited with being the most effective, and the velocity seems to make little difference, so long as it is sufficient to secure adequate penetration.

Effect of Bullet Energy

The striking energy of a bullet is a much better measure of its stopping power than is either weight or velocity, but even the energy is not a satisfactory criterion, for the amount of energy possessed by a bullet may bear little relation to the amount it delivers to the object it strikes. For example, a small calibered jacketed bullet may go all the way through a man without losing much of its velocity, and thus carry most of its energy away with it; while a large calibered lead ball with a blunt point may expend most of its energy in forcing its larger diameter through the flesh, and very often it may stop in the body, in which case it has delivered all of its energy to the object struck.



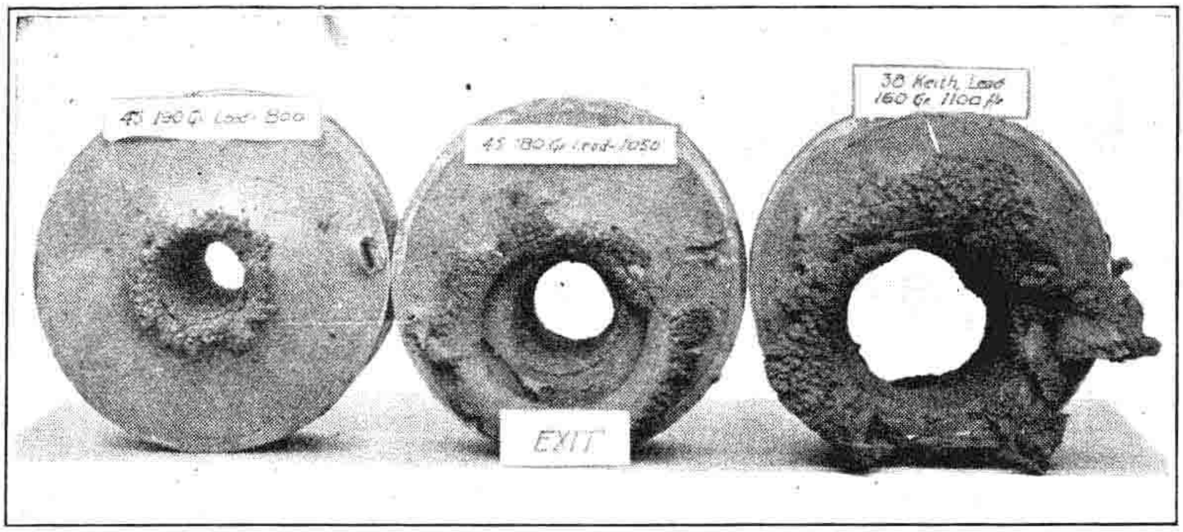
The relative disruptive effect of bullets on plastic materials, as tested by firing into clay. These pictures of the entrance side of the clay cylinders indicate that increasing the velocity of the .45 automatic pistol bullet from 800 f. s. to 1050 f. s. causes it to make a hole with approximately twice the diameter. However, the square pointed .38 Keith bullet makes a hole nearly twice as large as the high speed .45. While the bullet making the larger hole in clay may be expected to have somewhat more effect in flesh than one making a small hole in clay, the relative effects of these three bullets in flesh are nothing like the results in clay. This is because the clay is soft and plastic, without strength, and thus is thrown in all directions with violence by a high velocity or a square point, while flesh is tough and fibrous, and cannot be thrown aside as is the clay.

And moreover, if two bullets deliver equal amounts of energy to the body, the wound produced may be much more serious in one case than in another. Thus the amount of energy actually expended by the bullet in the body does not measure either the killing effect or the stopping power. A thrust with a dagger, which may kill in a few minutes, will deliver far less energy than a blow from the fist. When a 6 foot man weighing 180 pounds trips and falls, the impact with the floor delivers 540 foot pounds of energy to his body, but this would probably not even injure him, though it is about double the total energy possessed by most pistol bullets.

But the energy possessed by a bullet is a most important factor in its ability to create shock, for large diameter and flat point will have little effect unless there is enough energy behind them to drive them through the tissues.

Effect of Bullet Diameter and Shape

As to diameter, it should be noted that the area of the hole that a bullet must punch through tissue is proportional to the *square* of the diameter. Thus a .45 caliber bullet makes a hole with over four times the area of that made by a .22. Thus with the same energy in both a .22 and a .45, the larger bullet might be expected to deliver four times the damage to tissue. But actually, the .45 has much more energy than the .22, on account of the greater weight, and therefore its ability to cause damage is much more than 4 times that of the .22.

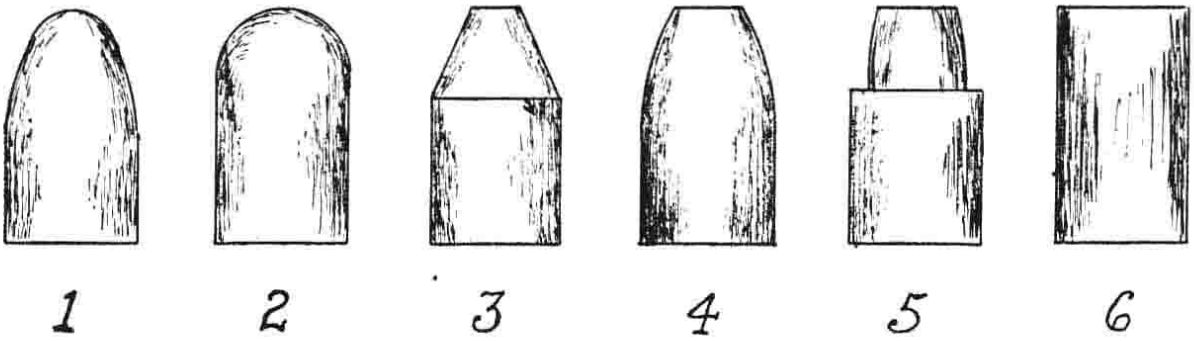


The relative disruptive effects of different velocities and bullet shapes on clay. Exit side of clay cylinders shot at with .45 Automatic Pistol bullet, 800 f. s., (left), and 1050 f. s. (center), compared with the effects of a .38 caliber Keith bullet, which has a square point and a ledge around the bullet. The results on clay do not in any degree indicate the effect on flesh, which is tough and fibrous, and does not react in the same way as a plastic material.

The shape of the point is a very important factor in stopping power. A square or blunt point offers greater resistance to penetration than does a sharp point; hence more work is done on the flesh by the blunt bullet in penetrating. Suppose, by way of illustration, that a truck is carrying a load of iron rods down the street at high speed, and a man who steps into the street at the wrong instant is struck and run through by a rod which projects in front of the load. If the rod has a sharp point, the damage will obviously be less severe than if the rod is square across the end. If, however, instead of a rod of iron, the projecting object which struck the man had been a telephone pole or a beam of wood, the man would be bowled over, but not penetrated at all.

While it is difficult to obtain a true measure of the relative effects of differently shaped points on bullets of the same caliber and velocity, an indication that there is a decided difference under some conditions may be obtained by firing into clay. However, the results cannot be taken as indicative of what happens in flesh, for the clay is soft and plastic, and has no strength, and is thrown in all directions by a sudden impact, or by having a blunt pointed bullet shot through it, while flesh is tough and fibrous, and does not act in at all the same manner. Nevertheless, the results in clay are interesting.

There are therefore included herewith photographs showing the front and back views of several cylinders of clay which have been



Bullet shapes with their relative disruptive power when fired against clay. These bullets are all for the .38 special cartridge, and when fired with the same velocity against a three inch thickness of clay showed the following relative disruptive power as measured by the energy left in the clay and the size of the cavity formed:

1. Regular .38 S. & W. Special shape. Disruptive factor 1.00
2. Western Super Police shape. Disruptive factor 1.25
3. Luger Shape. Disruptive factor 1.40
4. .38 Colt Special shape. Disruptive factor 1.50
5. Bullet designed by Elmer Keith. Disruptive factor 3.00
6. Wad cutter shape. Disruptive factor 3.50

It does not follow that the efficiency on flesh or bone follow these ratios, as clay is much more plastic than flesh.

fired at by the .45 caliber automatic pistol bullet at 800 f.s.; by the .45 caliber automatic bullet at 1050 f.s., and by the .38 Keith bullet at a velocity of 1100 f.s.

The first hole by the automatic is about twice the diameter of the bullet; the higher velocity one is nearly twice the diameter of the first; and the hole made by the smaller Keith .38 is nearly four times as large as the first and nearly twice as large as the second .45 caliber hole. This is due to the fact that the Keith bullet has a flat nose and a ledge around the large diameter of the bullet; these throw the clay outward with violence as the bullet plows its way through the soft plastic mass.

There is also a rough sketch by the author showing six different shapes of .38 bullets that were fired through clay. There was a tremendous difference in the energy left in the clay by the different shapes. The regular .38 Special shape, which is about the same as the .45 Automatic, was by far the least efficient in clay. The round nose, as used on the .38 Western Super Police, was about 25 per cent more efficient; the Luger shape, a truncated cone, with flat point, showed forty per cent more efficiency, the .38 Colt Special showed fifty per cent more efficiency while the .38 Keith bullet delivered fully three times as much energy and the wad-cutter three and one-half times as much as the regular shape when fired through three inches of clay. Somewhat surprisingly the hollow nose man stopper gave just the same results as the wad-cutter. This was no doubt due to the fact that the bullets did not distort or change their shape greatly on striking the clay.

If these same proportions held good for flesh we could use them in our calculations of stopping power, but unfortunately clay does not give us a true picture of the results obtained when a bullet strikes actual flesh. The reason is that while clay has mass, weight, and consistency that are reasonably comparable with those of flesh it has no strength. When a bullet plows through clay with high velocity, it throws the particles in all directions and makes a large hole. But when it plows through flesh the bullet cannot throw the particles freely to the sides, for the flesh is tough, fibrous and strong. You can poke your finger into clay, but not into flesh. Flesh acts to the bullet more like the rubber of a tire, with cotton cords vulcanized into it.

An important consideration in connection with shape of the point, is the fact that as soon as it hits a bone the point becomes flattened, no matter what shape it was previously. Thus the relative effect of the shape of the point applies more particularly when only flesh is traversed.

Then again a very important factor is the presence or absence of a jacket on a bullet. Bullets which are jacketed with gilding metal, cupro-nickel, or steel do not change their shape as much or break up as easily on contact with bone as do lead bullets. Moreover these jacketed bullets will glance off a bone unless the impact is nearly at right angles. When they do penetrate a bone near the edge they just make a small gutter through it, whereas lead bullets have a tendency to bite in and turn over, causing a much more serious fracture. For this reason jacketed bullets are less efficient in killing power than plain lead bullets.

Effect of Bullet Stability

A most important factor in stopping power, more especially in rifle bullets is the balance and gyrostatic stability of the bullet. Rifle bullets are generally very long in relation to their diameter; and when they strike fairly solid objects such as flesh or bone they tend to upset or turn end over end, thus creating very serious wounds. This tendency is particularly noticeable in some of the modern military bullets of small caliber, such as the 6.5 mm. used by several nations. These bullets are so small in diameter that they do not have much radius of gyration and they upset or turn end for end when striking flesh.

In the old days about 1870 and 1880 military rifle bullets were usually of .45 caliber or larger and made of plain lead with velocities of about 1300 foot seconds more or less. They had very satisfactory stopping power. Somewhat later they were superseded by small caliber, jacketed bullets with velocities of about 2,000 feet per second such as the Krag. These bullets had relatively good stability and possessed very little stopping power except for head shots or other vital wounds. Later about 1906 the velocity was stepped up further to about 2500 or 2800 feet per second, and many of the nations adopted small calibers such as 6.5 mm., (.256 inch). These bullets again showed stopping power and this change was due to two things. First the relatively low stability of pointed bullets and second the explosive effect encountered when bullets of velocities of 2400 foot seconds and over struck cavities containing fluid such as, for example, the skull with the brain in it which as in this case acts as a semi fluid.

The effect of bullet stability is not of great importance in connection with the study of the stopping power of pistol bullets because most pistol bullets are short in relation to their diameter so that they would not make much more of a wound going side ways than they would going point on; and moreover their stability is usually sufficiently high so that they have no great tendency to turn over unless a bone should be struck.

There are perhaps, one or two exceptions to this rule. The .38 Super Police is very long in relation to its diameter and would do a considerable amount of damage if it turned over. Another case is that of the .455 Webley Mark II which has a long rather sharply pointed lead bullet. Very likely this bullet also depends somewhat on its tendency to tip over when striking for its very satisfactory effectiveness.

Effect of Location of the Shot

Of far more importance as regards stopping effect than any of the factors mentioned above is the location of the shot or whether or not it strikes large bones. Even a small caliber, low powered bullet such as the .22 will render a victim instantly unconscious and cause death in a few moments if it pierces the brain. Any pistol bullet of moderate energy will have 100% stopping power if it pierces the bones of the legs or if it strikes the heart or one of the large nerve centers. However, even a very large caliber bullet with high striking energy and very great theoretical stopping power may be entirely ineffective if it fails to strike any of these points and traverses only flesh, or perchance after traversing flesh strikes an unimportant bone as it leaves the body.

An often quoted instance is the case of Antonio Caspi reported in Colonel La Garde's book *Gunshot Injuries*. The circumstances were as follows: "Antonio Caspi, a prisoner on the island of Samar, in attempting to escape on October 26, 1905, engaged in a hand-to-hand encounter with a guard, during which he was shot four times with a .38 caliber revolver loaded with Government ammunition. Apparently uninjured by the shots, he continued to fight until he was stunned by a blow on the forehead by the butt of a carbine. When he was examined in the hospital, it was found that the first bullet had entered his chest near the right nipple, ranged upward, backward and outward, perforating a lung, and escaping by passing through the edge of the right shoulder blade. Bullet No. 2 entered the chest near the left nipple, passed upward, backward, and inward, perforating the left lung, and lodging in the tissues under the skin of the back; the third entered the chest near the left shoulder, and passed downward and backward, perforating the lung and lodging in the back; while the fourth entered the palm of the left hand and escaped through a wound in the front surface of the forearm."

Three of these bullets perforated the lungs, and two of them, carrying 220 foot pounds of energy, stopped in his body. Any one of these three might have been expected to have stopped Caspi at once; yet a blow on the forehead by the butt of a carbine, carrying only a fraction of the energy delivered by the bullets stopped him where the bullets had utterly failed to do so. In three weeks he was discharged from the hospital cured. The significant thing about this case is that none of the bullets damaged any important bone, or traversed anything but soft tissue, with the exception of the one that chipped a small piece from the shoulder blade in passing out. Had any of the bullets struck the brain, spinal cord, or bones of the leg, he would have stopped at once.

An even more remarkable case was told the author by Col. Edwin Butcher, of the Army, who described an incident that happened while he was stationed at Fort Duquesne, Wyoming. The State at one time ceded the land of the Fort to the Federal Government and when the survey was made there was a discrepancy between the State and Government Surveys that left a small strip of land outside of the Fort which was disclaimed by either State or Government. Finally a civilian found this out and established a saloon there and as he was on neither Government nor State land, he was not bothered by anyone and a number of questionable characters soon began to congregate in his place.

One day a half-breed Indian and a tough white man, whom we will designate as Smith, though that was not his real name, held up a judge in Laramie, and brought their spoils from this holdup to the saloon in question, where they began to divide the loot. They quarreled over the division, and as the saloon keeper knew that they were both desperate characters, he told them that if they were going to quarrel they would have to do it outside. At this, both left the saloon, the Indian going first. As he descended the steps from the front door, Smith placed a .45 Caliber Single Action Colt against the back of his neck and fired. The bullet just missed his spinal column, and carried away part of his jaw. The Indian then reached for his gun, and as he turned around, Smith placed his revolver against the Indian's right arm and fired again. The bullet just missed the bone and went through the flesh of the arm into his chest, carrying away a large portion of the breastbone. The Indian then fired five shots at Smith, all of them piercing his heart. He then rode some miles into the desert where he was later found lying beside his horse, exhausted from loss of blood. He was put in a buckboard, brought back to the Post and the wounds were washed out with a solution.

Colonel Butcher saw this done. These were terrible wounds as the muzzle of the gun was right against the man in both cases. The flesh was badly burned and very badly torn. When the wounds were washed out with solution, large chunks of bone floated out especially from the chest wound where the breastbone was shot to pieces. After these wounds were dressed, the Indian was placed on a mattress on the guardhouse floor. In a few weeks he was entirely recovered and was tried for the murder of Smith for which he was acquitted, and for the holdup of the judge for which he received twenty years in the penitentiary.

Note also in this case, that the bullets struck neither the spinal column, the brain, or the arm bones. If they had, the Indian would have been unable to shoot. Smith lost his life because he did not realize that stopping power depends very largely on the location of the shot. Had he shot the Indian in the back of the head, instead of the neck, the fight would have ended at once.

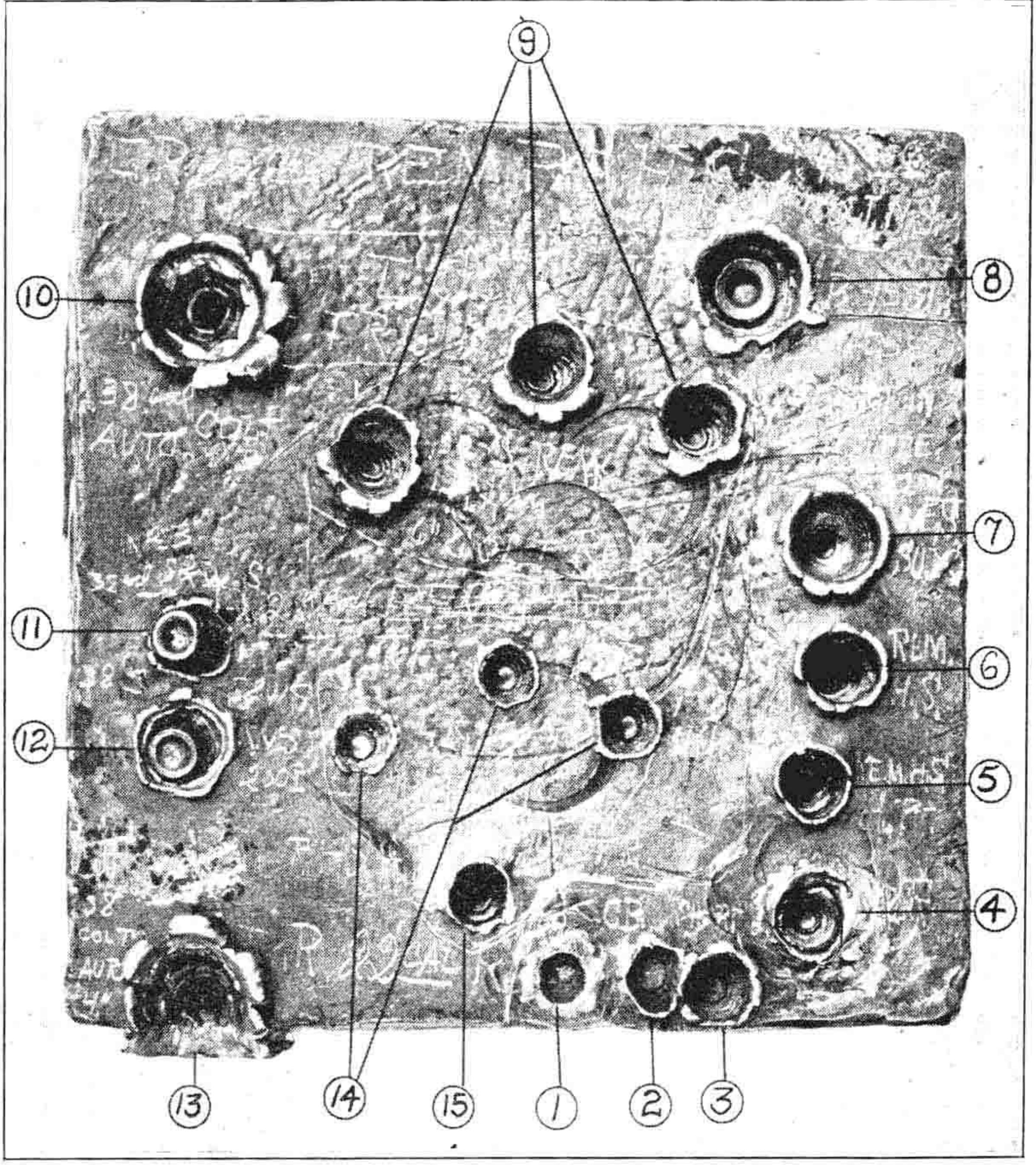
Tests of Stopping Power

There has always been a great deal of curiosity as to the relative stopping power of pistol and revolver bullets, and many incidents similar to those recounted above have been collected, but this evidence is not very satisfactory from a scientific point of view, as too many variables always enter. Much depends on just how the shots were placed, what organs they struck, the physical condition of the person shot, and many other factors. Moreover, these cases generally do not furnish any good basis for comparison of the relative effectiveness of the different calibers, velocities, bullet shapes, etc.

To get away from these uncertainties, and obtain a real comparison of stopping power that is based on scientific tests and will stand analysis is very difficult. In the first place, no satisfactory substance is available as an object to shoot at which we can be sure will act the same as living flesh does under the bullet impact. Clay has often been tried, but it lacks the necessary toughness and fibrosity of flesh, and is too easily thrown outward by the bullet as it plows through at high velocity.

Yellow laundry soap has often been tried for the same purpose, as it is of very much the same order of density as flesh; but it, too, like the clay, is much more plastic than flesh, and probably gives a highly exaggerated idea of what may happen.

Lead seems very dense and tough; but under the impact of bullets moving at high velocities, it also becomes quite plastic, and behaves something like the clay and the soap; with the difference that it stops the bullets very quickly. Mr. L. Cloud Newman of Washington, D. C., made an interesting series of firings against a lead plate with various pistol bullets. A photograph of this plate, with a description of the results is included here.



A lead plate an inch and a half thick against which various pistol bullets were fired by Mr. Newman. Nos. 1 to 7 were fired from a rifle with 20 inch barrel; the others from revolvers or pistols.

No. 1, .22 BB Cap, fired from rifle. No. 2, .22 CB Cap, fired from rifle. No. 3, .22 Short, fired from rifle. No. 4, .22 Long Rifle, fired from rifle. No. 5, .22 Remington Hi-speed hollow point, fired from rifle. No. 6, .22 Remington Hi-speed, fired from rifle. No. 7, .22 Western Super X, fired from rifle. No. 8, .45 Colt, from New Service Revolver 5½ inch barrel. No. 9, .22 Remington Plama Hi-speed from 6 inch revolver. No. 10, Super .38 A. C. P., from 4 inch barrel No. 11, .38 S. & W. Spl, from 6 inch revolver. No. 12, .38 S. & W. Spl. Super police, 200 grain, from 6 inch revolver. No. 13, Super .38 Automatic from 4 inch barrel, same as No. 10. No. 14, .22 Long Rifle in 6 inch revolver No. 15, .22 Remington Hi-speed hollow point in 6 inch revolver. The following data were obtained from measurements of this plate:

Number	Caliber	Diameter of hole	Depth of hole	Volume of hole, cu. ins.	Weight of lead displaced, grains
1	.22 BB	.32	.15	.012	34
2	.22 CB	.38	.18	.018	53
3	.22 Sht.	.44	.30	.046	130
4	.22 L. R.	.50	.38	.075	215
5	.22 H. S. H. P.	.50	.42	.083	237
6	.22 H. S.	.55	.50	.118	339
7	.22 Super X	.60	.55	.155	445
8	.45 Colt	.72	.35	.142	408
9	.22 H. S.	.50	.40	.079	226
10	**Super .38**	.80	.65	.326	**935**
14	**.22 L. R.**	.40	.23	.029	83
15	**.22 H. S. H. P.**	.40	.38	**.048**	**137**

Note—11, 12, and 13 could not be measured.

Some years ago a number of tests were carried on by shooting into human cadavers, and still other tests were made by shooting live animals on the killing floor of an abattoir. These tests are described in Col. La Garde's book, *Gunshot Injuries,* previously mentioned.

The results of shooting against cadavers do not give a close comparison with what happens when a live animal is shot, for after a man or animal dies, the flesh coagulates more or less as rigor mortis sets in, and this change and hardening of the tissues is rendered more pronounced by the pickling of the body in preserving fluids. About all that such tests tell is the relative action of the different bullets on bones, and even here, there is much that is unsatisfactory, because bones differ greatly in brittleness, according to the age and condition of the subject, and moreover, it is difficult or impossible to insure that all shots strike in the same manner. Then again, the effect of a bullet on dead meat, where the blood has all drained out of the vessels and the tissues have lost their natural fluids as well as their elasticity, might be expected to be entirely different from the effect of the same bullet on a live animal, where the natural fluids are present to transmit the shock, and the tissues are in their normal condition, so that the effects on the various layers of tissue and the blood vessels, etc., can be observed.

But even were live animals available for such tests, the matter would be far from simple, for any two animals differ from each other, and it would be difficult to compare two different bullets when the objects shot with them differ even more perhaps, than the bullets themselves. Then, too, there is the difficulty of insuring that all the shots strike the same kind of tissue. When a bullet strikes a bone, it may turn over, or glance in almost any direction, with widely varying results for nearly similar shots.

However, the tests described in Col. La Garde's book are far more comprehensive and complete than any other such investigation of which we have any published description, and a study of the results gives the best basis for forming an opinion as to the relative effectiveness of the different calibers that is available today.

Tests Described By Col. La Garde

Because the stopping power of the Army .38 caliber revolvers had shown itself unsatisfactory on numerous occasions in the Philippines and elsewhere, the War Department in 1904 constituted a board, consisting of Col. John T. Thompson, Ordnance Department, (The inventor of the Thompson Sub-machine Gun), and Col. Louis A. La Garde, to conduct a series of tests with bullets of different sizes, weights, and other characteristics, to determine which of the bullets then in existence had the stopping power and shock effect at short ranges that had been found by experience to be necessary for a pistol in the military service.

Caliber	*Weapon*	*Bullet type*	*Bullet weight grains*	*Velocity foot secs.*	*Energy foot pounds*
.30 (7.65 MM)	Luger Automatic Pistol	Jacketed	92.6	1420	415
.38 (9 MM)	" " "	"	123.5	1048	301
.38	Colt Army Revolver	Lead	148	763	191
.38	Colt Automatic Pistol	Jacketed	130	1107	354
.38	" " "	Soft Pt.	120	1048	293
.45	Colt New Service Revolver	Lead	250	720	288
.45	" " " "	Hollow Pt.	220	700	239
.455	" " " "	Man Stopper	218.5	801	288
.476	" " " "	Lead	288	729	340

The Luger pistols used in these tests were practically identical with those in use today. The 9 MM bullet had the same weight, shape, and velocity as the present conical flat pointed bullet. The .30 Luger had a slightly higher velocity than the present cartridge of that caliber, and had a bullet shaped like a truncated cone, with a flat point, the same as the 9 MM, instead of a round nosed bullet, as does the present .30 Cal. Luger.

The .38 Army Revolver used the .38 Long Colt Cartidge, at that time the Army standard.

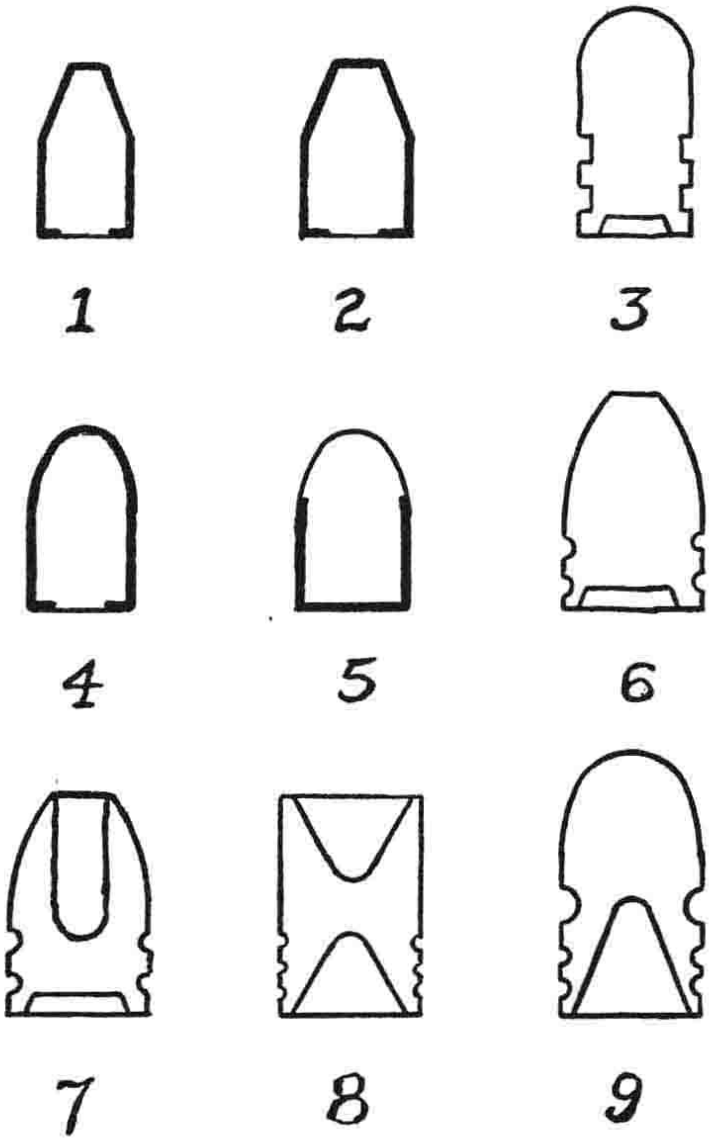
The Colt Automatic Pistol, Caliber .38, Military Model 1902, was the progenitor of the Super .38 Automatic of today, and had the same cartridge and bullet. However, the velocity, 1107 f.s., was about 85 f.s. lower than the average velocity of the same cartridge today. Note that in addition to the regular jacketed bullet, a soft pointed one was furnished.

The .45 Caliber Colt New Service Revolver was chambered for the old .45 Colt Cartridge, which in the tests fully justified its reputation as a powerful hand gun load. A hollow point, or express type bullet was also furnished, but apparently was not particularly more effective.

The .455 Caliber Colt New Service Revolver was used with the Man-stopper bullet, which has a square point with a cup-shaped depression in it.

The .476 New Service Revolver was furnished with a cartridge having a round nosed lead bullet weighing 288 grains, and driven at a moderate velocity. It proved to be the most effective of all. The author has one of the original .476 cartridges that comprised the lot used for this test.

These tests were of greater interest, because they included both the old style .45 Colt, with its massive, slow bullet of large caliber, and the then ultra-new automatic pistols with high velocity small caliber jacketed bullets having very high muzzle energy. The



Bullets used by Cols. Thompson and La Garde in their tests against cadavers and live animals in 1904. The bullets are arranged by caliber, and their relative stopping power was found to be about in the same order.

1. .30 cal. Luger, jacketed. Weight 92.5 gr., 1420 f. s., 415 ft. lbs.
2. 9 mm Luger, jacketed. 123.5 grains, 1048 f. s., 301 ft. lbs.
3. .38 Long Colt, Lead. 148 gr., 723 f. s., 191 ft. lbs.
4. .38 A. C. P., jacketed. 130 gr., 1107 f. s., 354 ft. lbs.
5. .38 A. C. P. soft point. 120 gr., 1048 f. s., 293 ft. lbs.
6. .45 Colt, lead. 250 gr., 720 f. s., 288 ft. lbs.
7. .45 Colt, hollow point. 220 gr., 700 f. s., 239 ft. lbs.
8. .455 man-stopper. 218.5 grains, 801 f. s., 288 ft. lbs.
9. .476 lead. 288 gr., 729 f. s., 340 ft. lbs.

results should be read with interest today, for we still have with us the argument of the Super .38 Automatic *vs.* the .45.

As revolvers are essentially short range weapons, it was decided that 75 yards would be the extreme range, 37½ yards the medium range, and close to the muzzle the short range. Simulated velocities were used for the first two; that is, the cartridges were loaded to a reduced velocity corresponding to 75 yards and 37½ yards respectively, and the shooting was done from a short distance.

The board in its tests fired into ten cadavers, sixteen beeves, and two horses. The shock on the cadavers was estimated by the amount of disturbance which appeared in a limb when the body was fired at when suspended by the neck. Col. La Garde states, "We found that the amount of shock as measured by this method was always proportional to (1) the sectional area of the bullet, (2) the resistance which the bullet encountered on impact, and (3) that it was proportional also to the amount of tissue destroyed. The diaphyses (shafts) of the long bones showed the greatest amount of resistance, and consequently the greatest amount of destruction, and the two latter—viz., resistance and destruction of tissue, which are so intimately associated with shock effects—were invariably greater when a larger caliber bullet was used.

"In attempting to define shock effects or stopping power in living animals we had to consider shots against—

1. Vital parts.
2. Non-vital parts.
3. The anatomy necessary to locomotion, or parts essential to activity.

(a) As one might suppose, all shots against vital parts from whatever arm showed immediate and complete stopping power.

(b) For shots in non-vital parts like the lungs, liver, intestines, etc., exclusive of large vessels, the shock or stopping power increased with the sectional area of the missile, and it was notably less with the smaller sectional area projectiles, although they possessed far more energy."

In an article in *Arms and the Man* some years ago, Stephen Trask discusses these tests rather more in detail than they are discussed in Col. La Garde's book. The following is quoted from Mr. Trask's article.

"Ten human bodies were the gruesome subjects for the first of the pistol and revolver caliber and velocity tests of 1904. They were cadavers which had been sent for dissection to the Philadelphia Polyclinic and to one of the large New York medical schools.

"In undertaking to fix the relative military value of different cartridges, and to discover which among those available were best adapted for use in short-range, rapid firing weapons of defense, Colonel Thompson and Colonel La Garde desired data for comparative study along several different lines. First, they wished to ascertain the nature of wounds inflicted when the bullets of different caliber encountered parts of the bony structure, including the head; second, they desired to know the character of injury inflicted by each of the hand-gun projectiles in the soft parts of the human body; third, they wished to fix beyond all doubt the relative shock effect exerted by the missiles in question.

"The wounds made by the bullets would, of course, speak for themselves if the channels were traced by dissection in the softer tissues and if the fractures of the bony structure were photographed. It was further agreed that so far as man-stopping was concerned, a shot upon an inanimate subject would be considered positive whenever one of the long bones was fractured.

"In the cadaver tests the bodies were suspended by the neck and permitted to swing, so that the oscillation caused by the impact of the bullets might be noted and considered in forming conclusions as to shock effects. In these tests Colonel Thompson did the shooting and Colonel La Garde made the examination of the wounds.

"During the tests upon the cadavers it was consistently demonstrated that the amount of oscillation, and consequently the shock effect, was always greater with the larger-caliber bullets. For instance, when the small-caliber projectiles struck the bone of an arm, or ploughed transversely across the small bones of the hand, the amount of swaying caused by the impact of the bullet was very small—more like a tremor than an actual oscillation—but when large-caliber bullets were used the oscillation was quite marked.

"The actual wounds were scrutinized both by the use of X-rays and by dissection. With these aids it was found that the channel of the wound generally corresponded in diameter to the caliber of the bullet, the wound of exit being slightly larger than that of entrance. Shooting into the joint ends of the bony structures, the evidence brought out was that when high-velocity, jacketed bullets were used, the tendency was toward clean perforation without fracture. When unjacketed lead bullets of lower velocity were used, fissures and fractures were almost invariably found in the joint ends, with only occasionally what appeared to be a clean-cut perforation.

"In the long bones, away from the joints, where the bony tissue is compact and very resistant, the tendency of the jacketed bullets was to make fractures at the area of impact, with occasional splitting and fissuring into the bone above and below the spot where the bullet struck. Sometimes the injury assumed the character of what is known as the 'butterfly fracture,' consisting of decided fragmentation in the center of impact with fissures extending on each side upward and downward externally to the surface of the bone, roughly forming an outline similar to that of the wings of the insect after which it is named.

"All of the perforations and fractures made by the jacketed, high-velocity projectiles, especially those of the 'butterfly type,' were observed to be of a character very easily healed.

"With the fractures made by the larger-caliber lead bullets, fired at much lower velocities, the reverse was generally true. In the compact substance of the long bones, they caused extreme fragmentation and usually lodged at the point of impact, splintering off bits of bone varying in size and causing long fissures in the bone shaft above and below the point of impact.

"Injuries to the head were productive of vastly different conclusions. A jacketed bullet of high velocity, fired through the brain, involved a tremendous amount of fragmentation in the skull cap. Such a wound would show a small orifice of entry with clean penetration, but a large area of fracture around the orifice of exit. For instance, when the bullet left the skull through the temporal bone, where the tissue is brittle, the exit was marked by many fragments completely isolated by fracture, and this extreme fragmentation even extended into the bones of the face in the case of bullets which passed from forehead to occiput, showing that the amount of energy delivered in the head as a whole was terriffic.

"A similar wound made by a lead bullet from a .38- or .45-caliber Colt was marked by an orifice of entrance accompanied by very slight fissuring; also, unlike the jacketed high-velocity bullet, which invariably passed entirely through the head, the lead bullet was apt to lodge against the opposite wall of the skull, making no orifice of exit and occasioning no fracture. This lodgment of the bullet was deemed probably due to the fact that the resistance of the skull at the point of first impact caused the bullet to flatten, increasing its sectional area, with a consequent limiting of its powers of penetration.

"From the tests on the cadavers, then, these conclusions were established:

"First. That in wounds involving the skull, greater explosive force was apparent in the impact of a high-velocity, steel-jacketed bullet than in the impact of a large-caliber lead bullet at lower speed. This fact, however, could not be regarded as in any way disposing of the question in hand, since regardless of fragmentation or other explosive effect, the lead bullets which flattened and lodged inside of the brain pan killed just as quickly and just as surely as the Luger bullet, which literally blew out the back of the skull in making its exit.

"Second. That in all bony structures, except the head, the fractures made by the unjacketed lead bullets of low velocity were much more serious injuries than the clean perforations or the easily healed 'butterfly' breaks from the Luger bullets.

"Third. That measured by the amount of swaying apparent, the large-caliber, lead, blunt-nose bullets exerted a greater smashing power upon impact than the high-velocity, jacketed projectiles. In this connection it was found that the jacketed projectiles, being longer in proportion to their diameters than the lead bullets, would fly straight and in most cases make a nose impact. On the other hand, the lead bullets would frequently turn in their flight, making a sidewise, or what is known to the rifleman as a 'keyhole' impact, and that they invariably turned after entering the body, gaining thereby in stopping power by virtue of added sectional area; also, the penetration of the lead bullets was so greatly reduced by the impact that they almost uniformly lodged in the body.

"Fourth. As to deformation in the different bullets, very little was apparent in the lead bullets, and none at all in the jacketed bullets. This finding coincides with the testimony of other surgeons who have studied the small-arms projectiles from a medico-military standpoint. The investigators in the tests of 1904 concluded that there is nothing in the way of resistance in the human body which tends to deform a jacketed pistol projectile.

"Now, while the tests upon the cadavers had established several facts of interest, the most important phase of the question—that concerning the actual man-stopping power exerted by the different bullets when fired into live tissue—remained unsettled, the degrees of oscillation evidenced in the swaying of dead bodies being no more than an indication of what was sought.

"The means of carrying out tests on living tissue, and at the same time occasioning a minimum amount of suffering, was found on the Nelson Morris killing floor in the Chicago stockyards. There arrangements were made for a series of quick-firing experiments in which a noncommissioned officer of the Army who was an expert with the pistol was directed to pump shots in the shortest possible time into steers about to be slaughtered. As soon as the effects of the shots had been noted, the animals were dispatched in the usual manner in vogue on the killing floor and without loss of time.

"The conditions under which the tests were made were these: The firing commenced with the smaller-calibered weapons, those of larger caliber following. The muzzles of the pistols were two or three feet from the animal. No shots were fired into vital parts, into areas traversed by the large blood vessels or into locomotor centers. It was agreed that if any animal failed to drop after ten shots in the lungs or intestines, the firing should cease and the animal should be dispatched.

"In commencing firing with the Luger, the animals were apparently not disturbed either by pain or shock. They evinced no alarm, simply turning their heads at the crack of the weapon and looking at the sergeant inquiringly. It was only after eight, nine or ten shots had been fired that they commenced to show any distress. In no instance with the .30-caliber Luger did any animal drop at the tenth shot.

"As the investigators worked up in the scale of calibers, it was found that the steers shot with the Colt .38-caliber automatic and the revolver of similar size showed greater distress, and that by the time six or seven shots had been fired they gave evidence of shock and exhaustion and dropped.

"With the .45-caliber Colt revolver the steers showed shock and distress after the fourth or fifth shots and then dropped.

"With the .455 and the .476, they dropped after the third or the fourth shot, and with the impact of the first bullet the shock effect was apparent in strong tremors through the entire body.

"In addition, the shock of the smaller-caliber pistols was not accompanied by hemorrhage; on the other hand, at the first or second shot from a .45 caliber weapon the animal would begin to bleed from the mouth and nose."

Several further quotations from Col. La Garde's book are given here, as they have an important bearing on the relative importance of energy, velocity, penetration, bullet diameter, shape and weight, on stopping power.

He says in part--"For the quick firing experiments (against live animals) we used the following calibers: .476, .455, and .45 from Colt's Revolvers; the .38-cal. Colt's automatic and the .30 Luger pistol which employed the metal-clad bullets. All of the bullets used in the experiments lodged in the body, so that every particle of energy was delivered with each bullet. The animals invariably dropped to the ground when shot from three to five times with the larger caliber Colt's revolver bullets, and they failed in every instance to drop when as many as ten shots of the smaller jacketed bullets from the Colt's automatic and Luger pistol had been delivered against the lungs or abdomen. This failure on the part of the automatic pistols of small caliber (and high velocity and energy) set at rest at once the claims of the makers that the superior energy and velocity of their weapons was a controlling factor in stopping power. The Board was of the opinion that a bullet which will have the shock effect and stopping power at short ranges necessary for a military pistol or revolver should have a caliber not less than .45.

"The tests showed that the .476 caliber lead bullet has the greatest stopping power. Its weight is 288 grains, muzzle velocity 729 f.s., muzzle energy 340 foot pounds. The .45 caliber lead bullet with slightly blunt point was next in stopping power. It weighs 250 grains with a muzzle velocity of 720 f.s., and muzzle energy of 288 foot pounds. A slightly blunt point has the advantage of making a bullet bite better in striking hard bone at an angle, or in clipping the edge of a vessel. All things considered, such a bullet is best suited for the military service in close combat.

"The board considered that cup shaped bullets, such as the 'manstopper' might be issued to troops fighting savage tribes, and fanatics in the brush or jungle. This bullet showed great execution on live animals. It weighs 218.5 grains, and has a muzzle velocity of 801 f.s. and a muzzle energy of 288 ft. lbs. The edge of the cup mushrooms readily upon striking cartilege and joint ends of bones thereby adding to its sectional area and stopping power.

"None of the full jacketed or metal-patch* bullets (all of which were less than cal. .45) showed the necessary shock effect or stopping power for a service weapon. They failed especially in the joint ends of bones and non-vital parts which comprise the larger part of the target area presented by the human or anical body.

"Shock effect depends upon the sectional area of a bullet and the amount of energy which it delivers at the point of impact. A full jacketed bullet which makes a clean fracture in bone and then leaves, takes the greater part of its energy in flight. When the bone is very resistant, or the jacket is marred, the bullet may disintegrate. Its sectional area is then increased, and it leaves energy in the body in proportion to the amount of metal which it deposits in the foyer of the fracture. When it lodges entirely, it parts with all of its remaining energy.

---

* Note—Apparently when Col. La Garde refers to "metal patch" bullets he means a bullet with a metal jacket around the core, and a soft-point.

"We are not acquainted with any bullet fired from a hand weapon that will stop a determined enemy when the projectile traverses soft parts alone. The requirements of such a bullet would need to have a sectional area like that of a 3-inch solid shot the recoil from which when used in hand weapons would be prohibitive."

Points that are particularly interesting are that the .30 Luger bullet, which had the highest velocity, energy, and penetration of any of the bullets used in the tests showed by far the least stopping power of any bullet used, even though it delivered all its energy by stopping in the animal for every shot. This disposes of the idea that energy delivered is a criterion of stopping power.

Moreover, note that the .38 automatic pistol which also failed to knock down any animal with ten shots is practically the same as the Super .38 automatic of today as far as ballistics are concerned. It is true that particular cartridges used in the tests gave a muzzle velocity of 1107 f.s., and that the Super .38 of today gives from 80 to 90 more feet per second, but this difference is insignificant, so that these tests can be taken as fairly representing the performance to be expected from the Super .38 under the same conditions. Ten shots from the .38 failed in every instance to knock down an animal, and four shots from the .45 Colt were the average required.

This result compares very favorably with the report of a correspondent who wrote to the author in regard to some experiences he had had in killing outlaw horses out west. He used the .38 Special, the .38 Super Automatic and the .45 Colt Automatic. He says, "I absolutely discarded the .38 Special. Even the 200 grain Western load didn't seem any better than the regular cartridge. The .38 Special cartridge has penetration, but lacks shock power, and that is what is necessary when the first shot counts. The Super .38 Automatic disappointed me very much. Give me the .45 Automatic every time. It hasn't the velocity or penetration, but the first shot drops them, for either head, body or shoulder shots."

In Col. La Garde's tests, note further that the soft point bullet with the .38 automatic gave no very different results from the jacketed bullet. The destruction on hard bone was somewhat greater, but in flesh the results were very much the same.

As to the effect of the shape of the point, note that the .455 man-stopper, which had the same energy and diameter as the .45 Colt had noticeably more stopping power, but the .476, which had a round point and a sectional area only about 9 per cent greater than that of the man-stopper had more stopping power. However, the .476 had about one-third more weight, which no doubt had its effect, especially as it was a long bullet of the kind that might greatly increase its sectional area if it turns over during penetration.

The tests reported by Col. La Garde give an important indication as to the probable answers to some of the questions regarding relative stopping power under the following headings:

1. *Relative effect of bullet velocity.* The tests indicate that within the range of velocities found in pistols, there is no marked difference in the results obtained with the highest and the lowest velocities available. Naturally, there is more penetration with the higher velocities, and especially with blunt pointed bullets, there is more smashing of bone, but there is no marked difference in the effects on flesh.

2. *Relative effect of bullet material.* On flesh there is little difference between the effect of a full jacketed bullet and of a lead one, or of a soft point bullet, or of a jacketed bullet with the metal of the nose cut so as to encourage mushrooming. None of these bullets will change their shape when traversing soft tissues. If a bone is struck, however, the lead or soft point bullet is distinctly more effective, for it will be flattened or distorted so as to increase its sectional area.

3. *Relative effect of bullet shape.* In flesh there seems to be little difference between the effect of a round nosed or a sharp pointed bullet and a square pointed one. However, the square or partly flat pointed shapes are much more effective in oblique or grazing shots on bones, where the round nosed types would have a tendency to glance, and the square nosed ones would bite in. Moreover, in passing close to blood vessels, the round nosed bullets may push them out of the way, while the square pointed ones will clip them. Thus the blunt pointed or flat nosed bullets are undoubtedly more effective.

4. *Bullet weight.* A bullet must have enough weight to insure

adequate penetration and shock to bones; but otherwise weight does not seem nearly so important as caliber. It will be noted, however, that the most effective bullets, namely, those of largest caliber, were also the heaviest, as large size naturally goes with large weight. But various tests and considerations indicate that the real factor in the effectiveness of the larger bullets is their increased sectional area rather than their increased weight.

5. *Relative effect of bullet diameter.* All the tests of which the author has any knowledge, as well as nearly all the scattered reports received from various sources, indicate that caliber is by far the most important factor in the stopping power of any bullet that has adequate energy to carry it well into a body. The nature of flesh is such that a bullet will not cause much destruction outside of a narrow path including the actual bullet track; and the width of this track, and of the consequent area of destruction of tissue, nerve material, and blood vessels varies with the square of the diameter of the bullets concerned, unless a bone is struck and the bullet thus distorted.

The Moral Effect of a Bullet Wound

We have stated above that the actual stopping power of any shot depends not only on the energy and other characteristics of the bullet, but also very largely on the location of the wound; that is, on whether or not the bullet reaches the heart or one of the large nerve centers, or shatters an important bone. Another factor of perhaps equal importance is the mental attitude and condition of the victim. A man of courage and determination, who is keyed up for something desperate will obviously be harder to stop than one who has no stomach for a fight, or who has no expectation of trouble and is taken by surprise.

The person who lacks "intestinal fortitude," if I may be pardoned for using this recently popularized euphemism instead of its shorter and more expressive, but less refined synonym, is likely to "fold up like a jack knife" and quit at the first sign of trouble, and any wound, however slight will put him out of the fight.

Once I heard a shot and the sound of a fall in an adjoining room, and my investigation disclosed a young man lying on the floor with a still smoking .32 caliber revolver beside him, and a flesh wound in the upper part of the left chest. He had attempted suicide, and though he had used the smallest and least powerful center-fire cartridge to be obtained, and the bullet had not reached a vital spot, he had dropped like a log at the shot, and lay there prostrated until he was wheeled off to the hospital to recover in a few days. Compare this case with that of Antonio Caspi who paid no attention whatever to three shots through the chest and lungs with a service revolver, and continued to fight savagely until he was pole-axed with a musket; or with the conduct of the Indian who killed his opponent and then rode his horse several miles after being shot through the neck and chest at close range with a .45 Colt!

Undoubtedly surprise is a big factor, and the easiest person to stop with any bullet is the man who has no expectation of being shot. In this class come hold-up victims who are suddenly confronted by a vicious killer and shot down in their tracks; pedestrians who are walking in some public place and unexpectedly come into contact with a gun-fight and are struck by a stray bullet; and murder victims who are shot without any preliminary warning as to their fate. Usually such persons immediately give up or drop, and undoubtedly the sudden emotional shock to the nervous system is a very important contributing factor; often such unsuspecting victims will go off their feet and down from such trivial causes as, for example, a .22 caliber bullet through the fleshy part of the arm. In fact, such persons are very apt to faint away instead of being knocked down.

More difficult to stop are the participants in some gun fight or shooting scrape where the bullets are flying, and the individuals concerned are aware of the danger. They are keyed up with excitement and intention, and when hit with a bullet are very hard to put off their feet; in fact, they are apt to treat with indifference any but a serious wound. Soldiers in the early stages of a conflict or escaping criminals who are determined to get away in spite of a barrage of fire from pursuing peace officers come in this class. They have something more important on their minds than worrying over a bullet wound, and in many cases after being hit they will continue to fight or run off as the case may be.

Finally we have the third and last class of individuals who are the most difficult of all to stop. These are the ones who are in a frenzy of rage at someone and out with the intention to kill and in the mood to kill or escape at any cost. The cases of Antonio Caspi and of Smith and the Indian, related earlier in this chapter are exact instances of what is meant. Here we have individuals with but one thought uppermost in their minds, namely, to kill or fight clear; every nerve in their bodies is on fire and they are edged up to meet and oppose anything in their paths, no matter what it may be. They do not even know they are shot until they see the blood coming from their wounds after the fight is over. The Philippine native who has gone Hourimantado, the tribesman who has run amuck, the Dillinger who has been chased for weeks, or the desperate convict under the death sentence who has determined to make a break for liberty all fit in this class. Here also belongs the soldier who has come through the early stages of a conflict, and is at last in a bloody hand-to-hand fight with the enemy. He has seen his friends and comrades shot down and done to death beside him, and he is intoxicated with excitement and rage. All these chaps have become so keyed up and desperate that they have made up their minds to die if necessary, but to do as much harm to the other fellow as possible before that occurs; and it is these individuals who require a .45 caliber bullet in a vital spot to stop them. Wild animals at bay also come in this class.

Tables of Stopping Power

In *Pistols and Revolvers and Their Use,* written by the author in 1927, the opinion was expressed that an approximation to the relative stopping power of various revolver bullets could best be obtained by a comparison of the striking energy of each bullet multiplied by the area in square inches of the hole that it makes, or in other words, the sectional area. It was also stated in that book that "there are other factors besides those quoted above which affect the stopping power of bullets. One of these is the shape of the point. A flat pointed bullet has much greater stopping power than a sharp- or round-pointed one. Another factor is the presence or absence of a jacket. The jacketed bullet seems to have less stopping power than one made of plain lead."

Ever since that was written the author has been trying to find out how much the table of stopping power should be modified for a bullet having a jacket, or for one having a square point. Numerous experiments have been made, but a clear cut answer to all these problems has not yet been obtained. However, pending the acquisition of further information, it is thought that the tables of relative stopping power would more nearly represent the actual capabilities of the various bullets if the figures for the jacketed bullets are reduced by ten per cent, and if the figures for the lead bullets are increased by ten per cent for those like the .38 Colt Special, which have a partly flat point, and by twenty-five per cent for wad-cutter bullets, or those with the Keith shape. Those figures have been introduced as a shape factor in the table of stopping power

TABLE I. FACTORS USED TO COMPENSATE FOR THE PRESENCE OR ABSENCE OF A METAL JACKET AND FOR THE SHAPE OF THE POINT IN COMPUTING THE STOPPING POWER OF BULLETS

Jacketed Bullets with rounded nose.	
.25 (6.35 MM) A. C. P.	.90
.32 (7.65 MM) A. C. P.	.90
.380 (9 MM Short) A. C. P.	.90
.38 (Super .38 Automatic) A. C. P.	.90
.45 A. C. P.	.90
.30 (7.65 MM) Luger	.90
.30 (7.63 MM) Mauser	.90
Jacketed Bullet with Flat Point.	
9 MM Luger	1.00
Lead Bullets with rounded nose.	
.22 Long Rifle	1.00
.32 Smith & Wesson	1.00
.32 Smith & Wesson Long	1.00
.38 Smith & Wesson	1.00
.38 Long Colt	1.00
.38 Smith & Wesson Special	1.00
.44 Smith & Wesson Special	1.00
Lead Bullets with blunt rounded point, or with small flat on point.	
.38 S. & W. Super Police	1.05
.38 S. & W. Special Super Police	1.05
.41 Long Colt	1.05
.45 Colt	1.05
Lead Bullets with Large Flat on point.	
.32 Colt New Police	1.10
.32-20 (.32 Winchester)	1.10
.38 Colt New Police	1.10
.38-40 (.38 Winchester)	1.10
.38 Colt Special	1.10
.44-40 (.44 Winchester)	1.10
Lead Bullets with square point or the equivalent.	
.22 Hi-Speed Sharp Shoulder	1.25
.38/44 Special with Keith Bullet	1.25
.455 Man-stopper	1.25

TABLE II. THE CROSS SECTIONAL AREA OF BULLETS IN SQUARE INCHES

Caliber	*Bullet diameter, inches*	*Sectional area, square inches*
.22	.223	.039
.25	.250	.049
.30	.309	.075
.32	.314	.076
9-mm. Luger	.354	.099
.38	.359	.102
.38/40	.400	.126
.41	.406	.129
.44/40	.426	.143
.44 Russian	.431	.146
.44 Special	.431	.146
.45 Automatic	.450	.159
.45 Colt	.455	.163

Using the figures given in the two tables above, the estimated shock power according to the formula in *Pistols and Revolvers and Their Use* can very easily be computed for any pistol cartridge by multiplying the muzzle energy as given in the ballistic tables by the shape factor and the area of the bullet as shown in Table II for each caliber. Such a table is given below, only for the purpose of comparison, as it has been superseded by one which follows, computed on a formula which uses momentum instead of energy.

Table III. The Estimated Stopping Power of Popular Pistol and Revolver Cartridges

(Sectional area of bullet in square inches times muzzle energy times a shape factor.) From Formula given by the present author in Pistols and Revolvers and Their Use, 1927. Now superseded by the momentum formula.

Cartridge	*Muzzle energy, foot pounds.*	*Sectional area of bullet, sq. ins.*	*Shape factor.*	*Relative stopping power.*
.22 Long Rifle, outdoor type	77	.039	1.00	3.0
.22 Long Rifle, Hi-Speed	107	.039	1.00	4.2
.22 Long Rifle, Hi-Speed Sharp Shoulder		.039	1.25	5.2
.25 (6.35 MM) A. C. P.	62	.049	.90	2.7
.30 (7.65 MM) Luger	290	.075	.90	19.6
.30 (7.63 MM) Mauser	329	.075	.90	22.3
.32 (7.65 MM) A. C. P.	140	.076	.90	9.5
.32 Smith & Wesson	75	.076	1.00	5.7
.32 Smith & Wesson Long	124	.075	1.00	9.3
.32 Colt New Police	120	.076	1.10	10.0
.32-20 (.32 Winchester)	232	.076	1.10	19.3
.38 Smith & Wesson	170	.102	1.00	17.3
.38 Colt New Police	170	.102	1.10	18.7
.38 Smith & Wesson Super Police	166	.102	1.10	18.7
.38 Long Colt	220	.102	1.00	22.5
.38 Smith & Wesson Special	260	.102	1.00	26.5
.38 Colt Special	260	.102	1.10	29.3
.38 Special Super Police	246	.102	1.10	27.5
.38/44 S. & W. Special	425	.102	1.00	43.4
.38/44 Special, Keith bullet	425	.102	1.25	53.2
.38 A. C. P. (Super .38)	417	.102	.90	38.3
.380 A. C. P. (9 MM Short)	150	.102	.90	13.5
.38-40 (.38 Winchester)	360	.126	1.10	50.0
9 MM Luger	300	.099	1.00	29.7
.41 Long Colt	220	.129	1.05	30.0
.44 S. & W. Special	320	.146	1.00	46.8
.44-40 (.44 Winchester)	375	.143	1.10	59.2
.45 A. C. P.	340	.159	.90	48.6
.45 Colt, 770 f. s.	330	.163	1.05	56.6
.45 Colt, 910 f. s.	460	.163	1.05	79.0

The author thinks that this table probably gives a closer comparison of the relative shock power of the various cartridges than can be obtained without some such compilation, and experience gained in many tests conducted since it was worked out indicate a fair agreement with experimental results; but for some time a feeling has been growing that the table gives too much weight to the velocity factor, and therefore places such cartridges as the .30 Luger and .30 Mauser with their high velocity and low bullet weight and small diameter too high in the list.

Much of the shock effect of any bullet is due to the throwing of particles of bone, flesh, body fluids, etc., to one side and the other as the bullet plows through the body. The factor that permits the transmission of velocity to other particles is not energy, but momentum, which is mass multiplied by velocity.

The use of momentum instead of energy in the formula would give a truer picture of the relative power of the different bullets to put into motion the particles with which they come into contact. Moreover, it would give the factor of bullet weight more importance. Perhaps the crushing and rending effect of a bullet of large mass on a bone is more serious than the effect of a small bullet at higher speed, which passes through so fast that there is scant time to communicate the effects to any structures that are not in immediate contact with the bullet.

To compute the relative stopping power by this method, first obtain the momentum of the bullet in pounds-feet, by multiplying the mass of the bullet by the velocity. The mass is obtained by dividing the weight *in pounds* by the constant of gravity, 32.16. To bring the bullet weight to pounds, divide the weight in grains by 7000, the number of grains in a pound. (Note—If the energy and velocity of the bullet are known, the momentum is obtained by dividing the energy by the velocity.)

After obtaining the momentum, multiply it by the sectional area of the bullet in square inches, and by the shape factor. The result will be the relative stopping power. This comes out as a decimal with three places, and to bring the results to whole numbers, which does not change the comparative values in the least, but looks less confusing, it is well to use the shape factor as 1000 for the standard bullet instead of 1.0. This would make the other shape factors 900, 1100, and 1250 instead of .9, 1.1, and 1.25 respectively.

It is interesting to plot the relative stopping power of the bullets used by Thompson and La Garde by both these methods and see which comes nearest to the results actually found by test. Bullets are arranged in the order of the relative effectiveness as reported in La Garde's book.

Bullet	*Weight grains*	*Velocity foot seconds*	*Energy foot pounds.*	*Relative stopping power, energy formula*	*Relative stopping power, momentum formula.*
.30 Luger	92.6	1420	415	31	22
9 MM Luger	123.5	1048	301	29.7	28.4
.38 Long Colt	148	763	191	20.5	27.0
.38 A. C. P.	130	1107	354	32.5	29.5
.45 Colt	250	720	288	49.5	68.4
.455 Man-stopper	218.5	801	288	58.8	73
.476	288	729	340	60.0	83

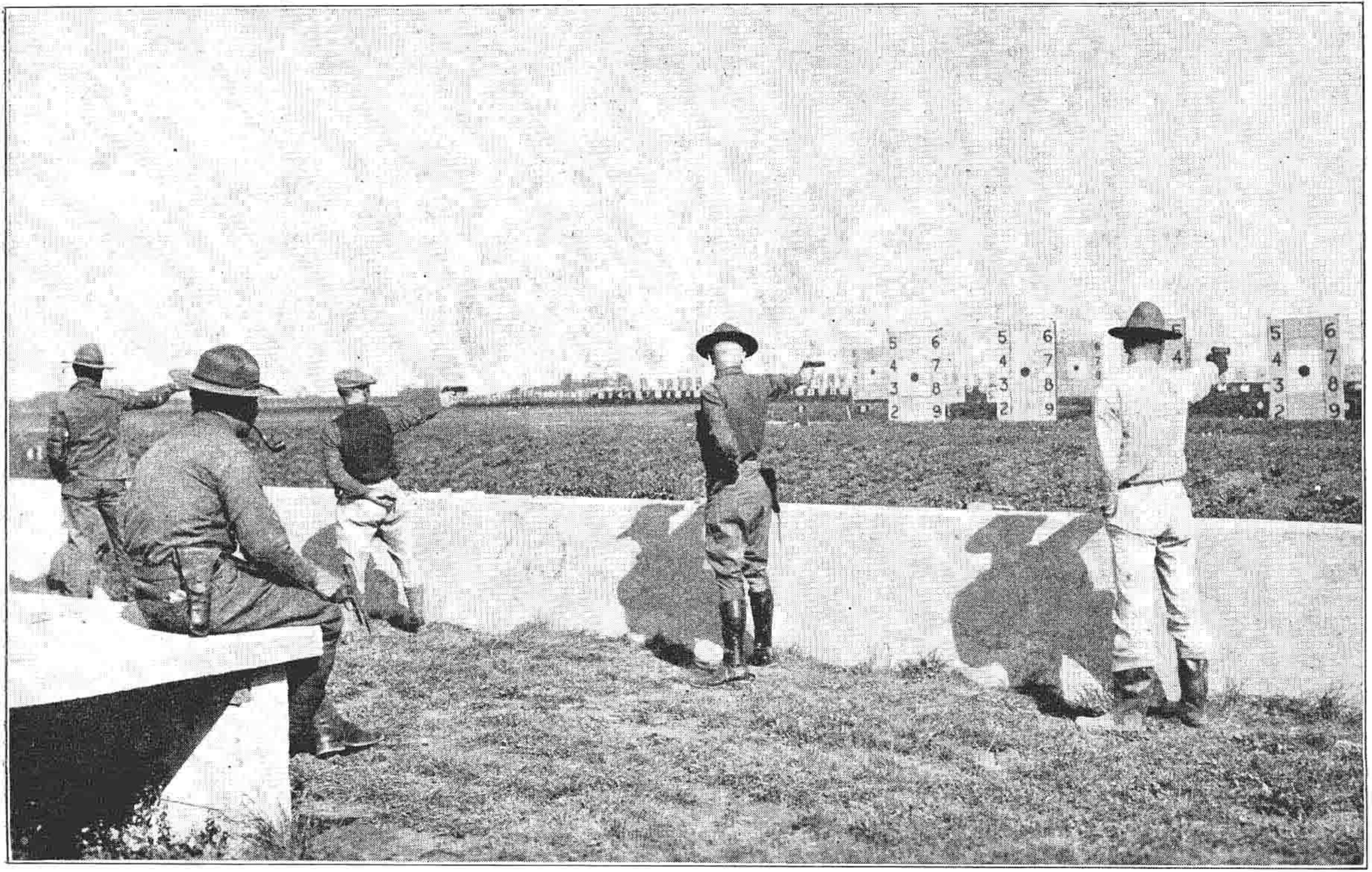
It will be seen that by the momentum formula, the figures are in substantial agreement with the results given in La Garde's book, where the .30 failed to down any animal after ten shots, while the .38 downed them after say seven shots, the .45 after say four, and the .455 and .476 after three.

While any formula of this kind is only an approximation at best, the author now offers the following momentum—sectional area—shape factor formula as the best method known by him at present for estimating the relative stopping power of pistol bullets, and as giving results that seem to be reasonably close to all the experimental data that have been gathered so far. This method is not fully applicable to rifle bullets because their stopping power often depends largely on "yaw" and the consequent tipping or upsetting of the bullet on impact.

TABLE IV. THE ESTIMATED STOPPING POWER OF POPULAR PISTOL AND REVOLVER CARTRIDGES

(Based on the momentum of the bullet times the sectional area times a factor to compensate for shape and bullet material.)

Cartridge	*Momentum, pounds—feet per second*	*Sectional area of bullet, sq. ins.*	*Factor for shape and material.*	*Relative stopping power.*
.22 Long Rifle Outdoor type	.083	.039	1000	3.3
.22 Long Rifle Hi-Speed	.097	.039	1000	3.8
.22 L. R. Hi-Speed Sharp Shoulder	.097	.039	1250	4.7
.25 (6.35 MM) A. C. P.	.083	.049	900	3.7
.30 (7.65 MM) Luger	.246	.075	900	16.6
.30 (7.63 MM) Mauser	.249	.075	900	16.8
.32 (7.65 MM) A. C. P.	.147	.076	900	10.0
.32 Smith & Wesson	.118	.076	1000	9.0
.32 Smith & Wesson Long	.165	.076	1000	12.5
.32 Colt New Police	.164	.076	1100	13.7
.32-20 (.32 Winchester)	.244	.076	1100	20.3
.380 A. C. P. (9 MM short)	.177	.102	900	16.2
.38 A. C. P. (Super .38 automatic)	.347	.102	900	31.8
.38 (9 MM) Luger	.288	.102	1000	29.4
.38 Smith & Wesson	.233	.102	1000	23.8
.38 Colt New Police	.240	.102	1100	27.0
.38 S. & W. Super Police	.273	.102	1050	29.2
.38 Long Colt	.272	.102	1000	27.7
.38 S. & W. Special	.302	.102	1000	30.8
.38 Colt Special	.302	.102	1100	33.3
.38 Special Super Police	.338	.102	1050	36.3
.38/44 S. & W. Special	.386	.102	1000	39.4
.38 Colt Spl. High Velocity	.386	.102	1100	43.3
.38/44 Spl., Keith bullet	.386	.102	1250	49.2
.38-40 (.38 Winchester)	.380	.126	1100	52.6
.41 Long Colt	.305	.129	1050	41.8
.44 S. & W. Special	.416	.146	1000	60.6
.44-40 (44 Winchester)	.408	.143	1100	64.2
.45 A. C. P.	.420	.159	900	60.0
.45 Colt, 770 f. s. velocity	.428	.163	1050	73.6
.45 Colt, 910 f. s. velocity	.505	.163	1100	87.4



A section of the pistol range at Camp Perry, Ohio, showing a few of the competitors shooting in one of the rapid-fire matches.

PART 3

SHOOTING

CHAPTER 13

LEARNING TO SHOOT

IF the average man who has never fired a pistol has one placed in his hand and is asked to try his skill with it, he will usually make a very sorry exhibition. Really there is nothing very strange about this.

If you should give a pen to a man who had never learned to write, he would not do well with his handwriting until after quite a bit of practice; and even after he learned to write rapidly he would find that his pen felt strangely wobbly and insecure if he took it in his left hand instead of his right. The reader can test this for himself. If he takes a pen or pencil in his left hand he cannot write well with it; he lacks control, his hand feels wobbly.

A pistol feels just the same way when it is first grasped by a man who has never handled one before. It takes practice in aiming and snapping the gun to make it feel natural, and a large amount of aiming and snapping with the empty gun should be performed by every aspiring pistol shot before he tries to shoot live cartridges.

After handling a revolver a few times the average man can aim and snap it at a target in such a manner that the target would be hit if the gun happened to be loaded and the user did not know it. However, if he did know that there was a cartridge in the gun he would be expecting a tremendous flash, noise and kick, and as a result he would tense all of his muscles just before firing, or as Mr. Woodworth of Springfield Armory describes it, he has a tendency to "shut both eyes and take both feet off the ground when he pulls the trigger." The result is that a shot would probably hit the ground about half way to the target. If the gun made no noise and had no smoke or recoil, it would not take the average person very long to be a good shot with it.

On this principle, it is best when learning to shoot to select a gun in which the noise and recoil are a minimum; that means the .22 caliber. Other advantages of the .22 caliber are the cheapness of the ammunition, which allows a great deal of practice for very little money, and the fact that the comparatively low power of the cartridge enables target practice to be done in places where it could not be done with a gun of larger size.

Several years ago there was one disadvantage to using the .22 caliber, and that was the fact that all .22 caliber guns were made small, as if they were intended for a child or very small woman; in other words, the size of the gun seemed to be controlled by the size of the bullet it shot more than by the size of the hand in which it was to be used.

However, it is fortunate that in the last few years a number of excellent .22 caliber pistols and revolvers have been produced which are the same size as a .38 or .45 caliber weapon, so that now after learning to shoot with a .22 the marksman will not find the larger gun strange or awkward.

Problems to be Solved

When the average man starts in to learn to shoot a pistol or revolver, he will at once be confronted by several problems, one of which will be to find a place to shoot. If he lives in a city or settled neighborhood this may be a very serious question. This phase of the matter will be discussed later, but it may be said at this point that a man may become really very well grounded in the principles of revolver shooting before having fired a single shot and even if the opportunities for actual shooting should be few, this should not deter the intending marksman from proceeding with the ground work of instruction.

This will at once bring out another problem, and that is the selection of a gun with which to begin practice.

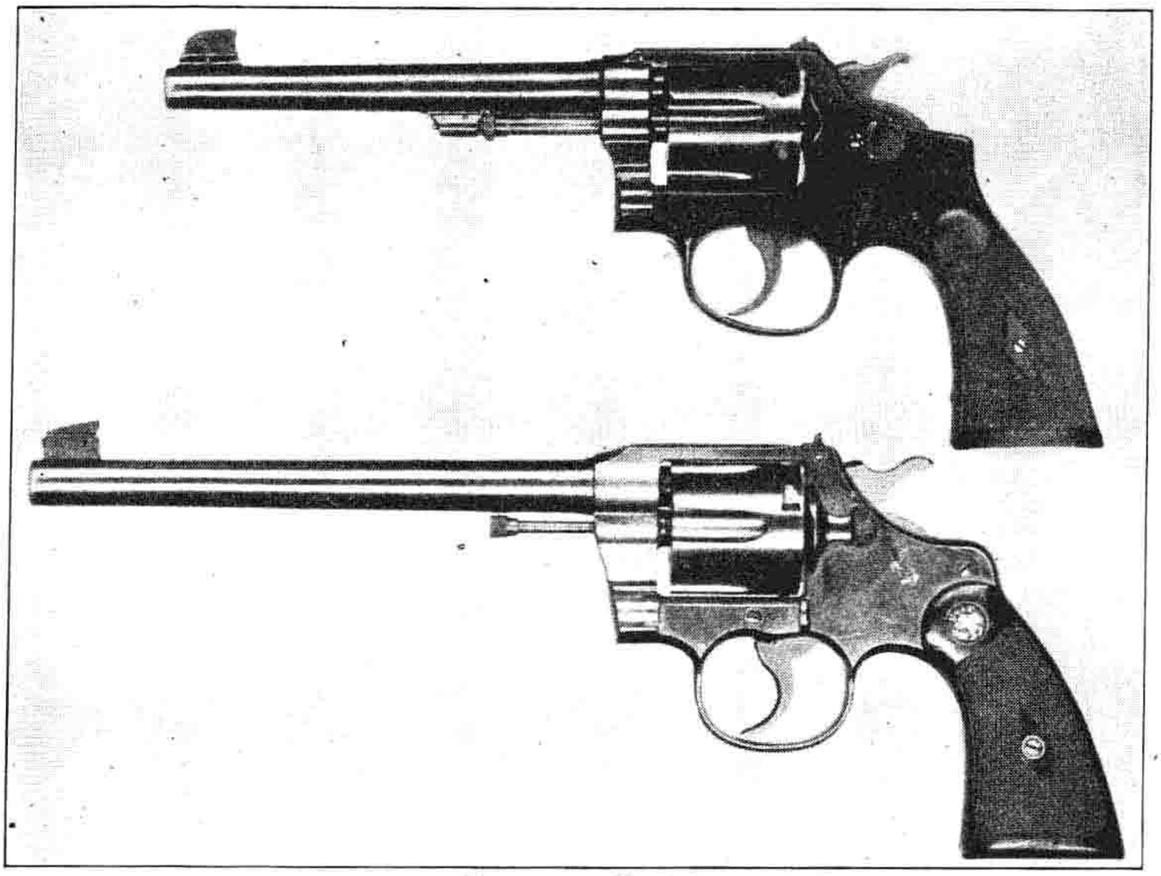
Selecting a Gun

We have already said that the first gun should be a .22 caliber; but this still leaves quite a wide latitude, because .22 caliber guns are made in three distinct types. These are the single shot target pistol, the target revolver and the automatic pistol.

The choice of a type of gun will depend to a considerable extent on the kind of shooting which it is intended to follow and the reasons for learning to shoot. It may be that the motive is merely a desire to become proficient in the use of hand firearms so that the knowledge of how to use them will be available should the necessity for their use for self-protection or other emergency arise.

On the other hand, the motive may be a wish to practice .22 caliber target shooting as conducted in the U. S. R. A. and N. R. A. clubs. Again, it may be that the marksman is interested only in military target shooting with large caliber revolvers. In each case a different type of gun may be the best.

If funds are not a serious object there is much to be said for the plan of starting in with a single shot target pistol in any case. This is the most accurate hand firearm of all and is by far the safest. Moreover, if you get really interested in pistol marksmanship, you will undoubtedly at some time want to enter some of the matches and you can never expect to get the very highest scores unless you shoot with a single shot target pistol.



Two favorite target revolvers. Top, the .38 Military & Police Target, sometimes known as the Model K, with 6 inch barrel. Bottom, Colt Officer's Model Target Revolver, with 7½ inch barrel.

On the other hand, if you are only interested in learning to shoot from a practical viewpoint so as to know how to use a revolver or automatic pistol on hunting and camping trips and the like, and you are perfectly sure that you are never going in for target practice, then you would save money by getting the kind of gun best suited for the shooting you eventually intend to do.

Of course, practical shooting can be done with the single shot target pistols, but most people prefer the convenience of a revolver or automatic pistol which does not have to be reloaded after every shot.

If you are practicing up to learn to be a military shot, you would probably want to get a gun which simulates as closely as possible the action of the Government .45 automatic pistol. The Colt Ace automatic pistol is like the Government automatic pistol in size, shape and appearance but uses the .22 caliber cartridge instead of the .45, and as an understudy for the Government pistol this should be your choice.

In chapter 2 you will find all of the .22 caliber target weapons described in detail and a study of this chapter may assist you materially in determining what gun you desire to use.

Learn Your Gun

After getting your gun, the very first thing to do is to learn as much about it as possible. You should learn how to load and unload it and what safety devices it has, if any, also how to adjust the sights and how to clean and care for the gun. Much valuable information of this kind can frequently be obtained from the catalogs or leaflets issued by the manufacturer. If you buy the gun from a local sporting goods dealer, the salesman will be glad to give you information along these lines.

In any event, be sure to learn when you get the gun how to tell whether or not it is unloaded; and every time you pick it up always verify this point. This is one of the most important of safety precautions.

Just to illustrate what may happen, I will tell you that once I knew of a case where a man received a rifle all packed in grease and wrapped in oiled paper just as it came from the factory. The first thing he did was cock the hammer and snap the gun, and to his amazement it went off, but fortunately no damage was done. When the gun left the factory a live cartridge was left in the chamber through some mistake and naturally the purchaser did not think the gun could be loaded under these circumstances and so did not look. The same thing might happen with a revolver.

Safety Precautions

Make it a matter of pride as well as of insurance against accident to study the safety precautions for the proper handling of firearms and observe them on every occasion. Remember that if you do not use the recognized safety precautions that are generally known and observed among those expert with firearms, you will be looked upon as ignorant and inexperienced. The first thing a man who knows about guns looks for in a newcomer on the range is the way he handles his weapon. A man who flourishes his gun around or handles it in an ostentatious manner, brands himself as ignorant of firearms and is a dangerous man to have in a club or on a pistol range.

It is also well to realize that accidents are much more likely to happen with pistols and revolvers than they are with rifles unless proper care is used. This is because a pistol or revolver is so short and easy to handle that it can swing around in any direction with extreme facility. If you have a rifle in your hand, for example, you are not likely to point it at yourself, but a revolver swings around so easily that it may be pointed in any direction, therefore the need for the utmost care.

While the revolver is potentially dangerous, all chance of accidents can be eliminated if each user will observe a few simple safety precautions, and it is a matter for congratulation that among the pistol and revolver clubs and at the National Matches where guns are being used constantly, there is practically never an accident. It is the man who is untrained and unfamiliar with firearms who causes the "didn't know it was loaded" accidents with which we are all so familiar in the daily papers.

The strict observance of the following precautions are absolutely essential:

1. Never point a pistol or revolver at anyone unless you want to shoot him, and never allow anyone to point a gun at you. In general, never point a gun whether loaded or not in any direction where it could do harm if it went off.

2. If you hand a gun to another or if a gun is handed to you, always open and examine it to see if it is loaded, first removing and examining the magazine.

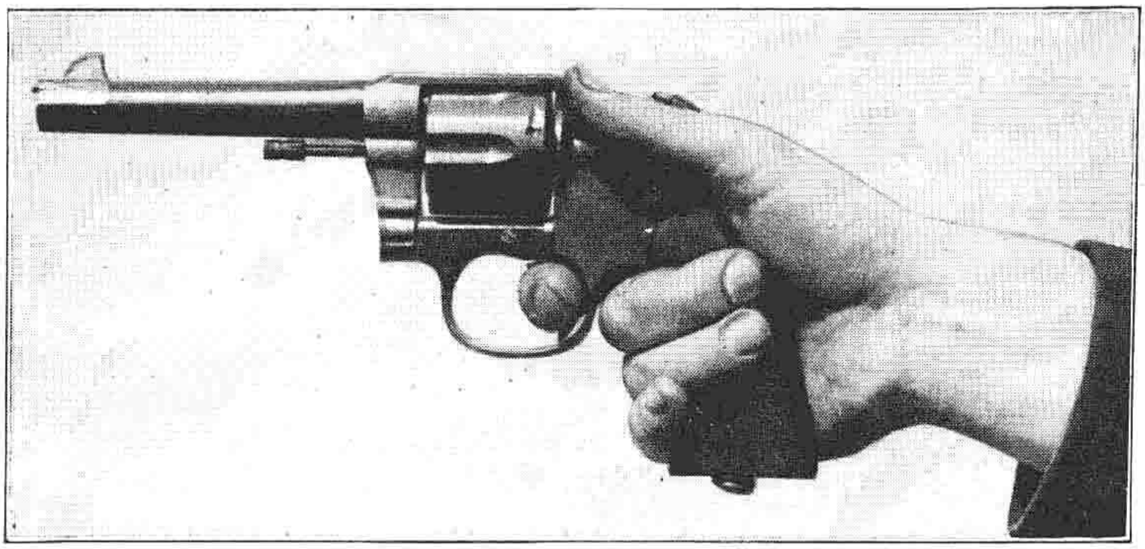
3. At matches or competitions always keep the cylinder swung out or if an automatic pistol, keep the slide latched back (except when actually on the firing line). Never aim or snap a gun back of the firing line. Army rules require these precautions and violations may result in the barring of the offender from the range.

4. Remember that with an automatic pistol taking the cartridge out of the chamber does not necessarily make it safe. There may be one or more cartridges in the magazine and when you shut the gun it is loaded again. Merely taking the loaded magazine out of the gun does not make it safe; a cartridge may remain in the chamber. Many fatal accidents have happened by neglect of these points. When you want to unload an automatic, always

remove the magazine first and after removing the magazine, look to see that there is no cartridge left in the chamber. Then work the action a time or two without snapping the arm.

5. In carrying a revolver loaded, always have an empty chamber under the hammer except in the case of hammerless guns or those having a positive hammer block operated by the trigger, such as the Smith & Wesson Patent Safety Hammer Block, the Colt Positive Lock, or the Iver Johnson Hammer-the-Hammer Safety.

Always take the precaution before shooting a gun to clean out any grease that may be in the barrel or cylinder. Sometimes grease is put in at the factory to keep the gun from rusting and there may be enough in the barrel to cause trouble if you fire without taking it out.



The preferred method of holding a revolver of large caliber. Note the high position of the hand on the grip, and the manner in which the thumb is held. The gun illustrated is the .45 Colt New Service.

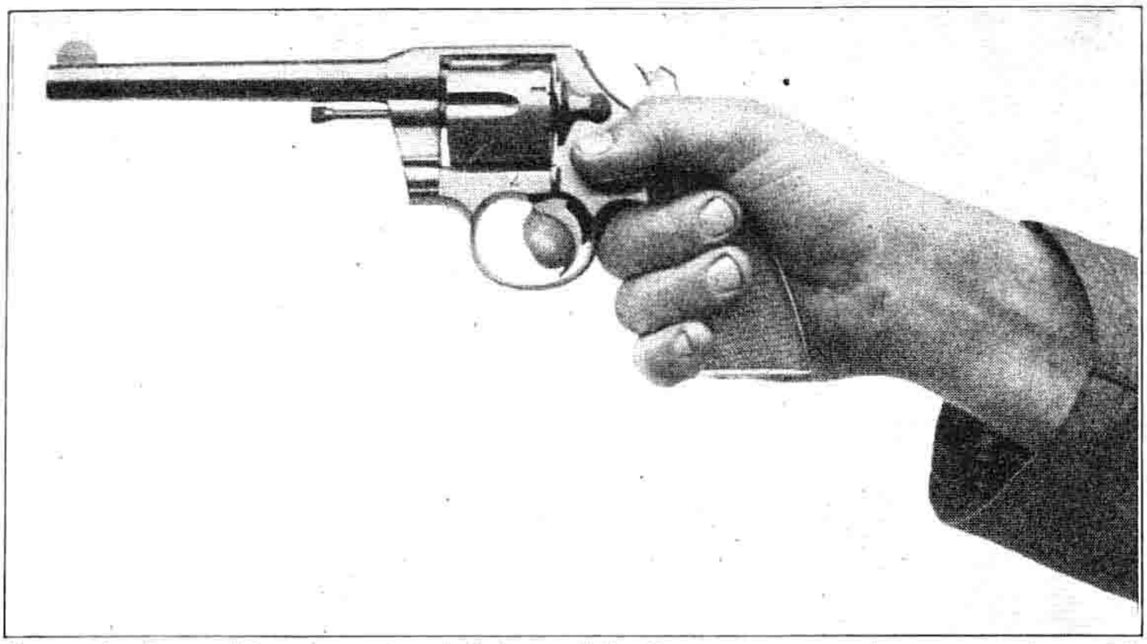
It is a very wise precaution to wear glasses when shooting either rifles or pistols, as sometimes the primers or head of the cartridge may leak and allow some gas to escape, with the risk of injury to the eyes.

In using heavy caliber guns, especially indoors, it is a very wise precaution to use cotton in the ears as continued firing will have a tendency to impair the acuteness of hearing unless this is done.

Immediately after shooting, always clean the gun and oil it with light oil if it is to be used again soon, or coat lightly inside and out with a rust preventive grease if it is to be put away for some time. A rag saturated with rust preventive grease pushed back and forth through the bore several times, will leave a thin film which will not interfere with shooting but which will stop the bore from rusting.

Holding the Gun

After you have learned all you can about the mechanism of your gun and about the safety precautions, the next thing is to practice aiming and snapping it until familiarity is obtained and until the trigger can be squeezed with such smoothness and coordination that the sights do not move when the hammer falls. Before you can start with this practice, you must know the proper method of holding the gun and the proper position in which to stand while shooting. Much can be learned from a study of the illustrations which accompany this chapter.



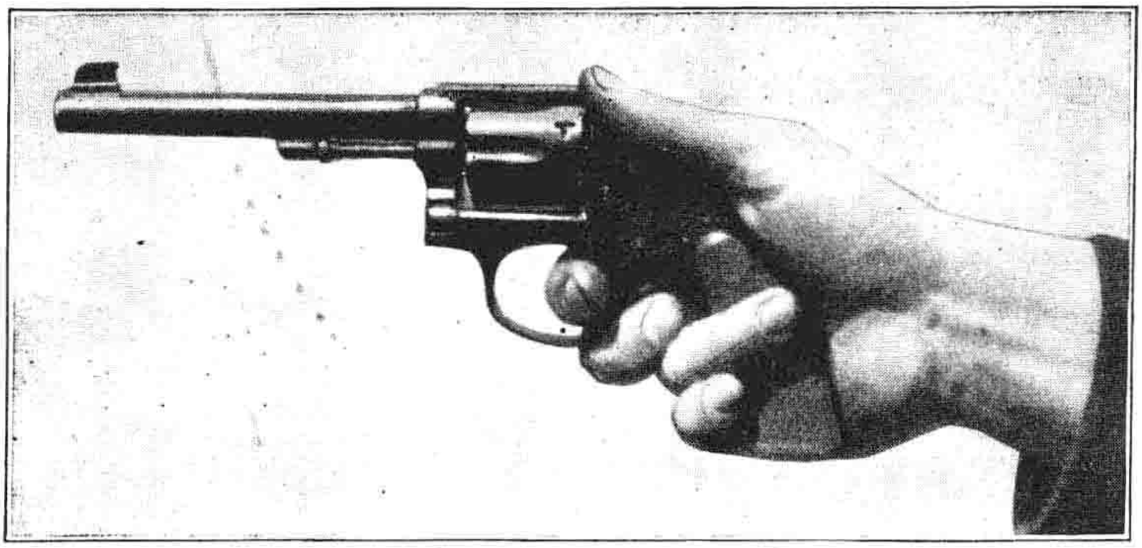
Some shooters with a large hand find no difficulty in grasping the gun so the middle finger fills the space in rear of trigger guard. Above is such a "grip" with the thumb bent down towards the trigger.

Of course, before you begin your snapping practice you must first take the proper standing position. In the practical use of a pistol you may have to fire in almost any direction and from a standing, sitting or prone position. However, you are generally standing and facing the object that you are shooting at.

In target shooting you do not have any such limitations of time or circumstances and, therefore, you can take the most ideal position, and this is with the target to the right front of the shooter, right foot pointing toward the target, left foot about 12 to 20 inches to the rear of the right foot and pointing to the left at an angle of about sixty degrees to the right foot. This position of the feet braces the body against swaying either forward or backward or from side to side.

The pistol is held in the right hand at the level of the eyes with the arm fully extended toward the target. The body assumes as comfortable a position as possible to balance the weight of the extended arm and the revolver, and this generally means that the shooter leans back slightly. It helps a great deal if the belt is grasped with the left hand, as this steadies the body remarkably.

The method of holding the pistol or revolver is a most important point in learning to shoot accurately. While a great many hints can be given which will aid the beginner in eventually learning the proper grip, it must be understood that at first the gun will feel awkward, the same as a pen does to a person just learning to write. However, practice will bring familiarity and the proper grasp will come with experience.



Some shooters find this an excellent way to hold a revolver that is not fitted with a grip adapter. Note that the back of the trigger guard rests on the second finger, and it in turn rests on the third, thus giving steadiness to the hold and supporting the gun in a vertical plane. This method of holding works well for either slow or rapid fire.

It should be realized at the outset that the exact method of holding the gun will vary according to the caliber of the gun and the amount it recoils, and also according to the type of weapon used. Obviously a .22 in which the recoil is negligible, can be grasped much more loosely than a .45 in which the recoil is considerable. Moreover, it is also quite obvious that the automatic pistol with its straight, flat stock must be grasped in a different way than a revolver with its curved handle.

No matter what kind of weapon is used or what method of holding is adopted, there are general observations that should be borne in mind. The most important of these is that while shooting can be done in several different ways, using various kinds of grasps, a change in the method of holding the gun will change the place where the bullets hit even when using the same sighting, hence it is best to learn a good method and stick to it so that your grouping will always be in the same place with regard to the line of sight. In other words, try to find the right grip as early as you can and avoid as far as possible changing from one method of holding to another from time to time, because this will delay your obtaining proficiency in marksmanship.

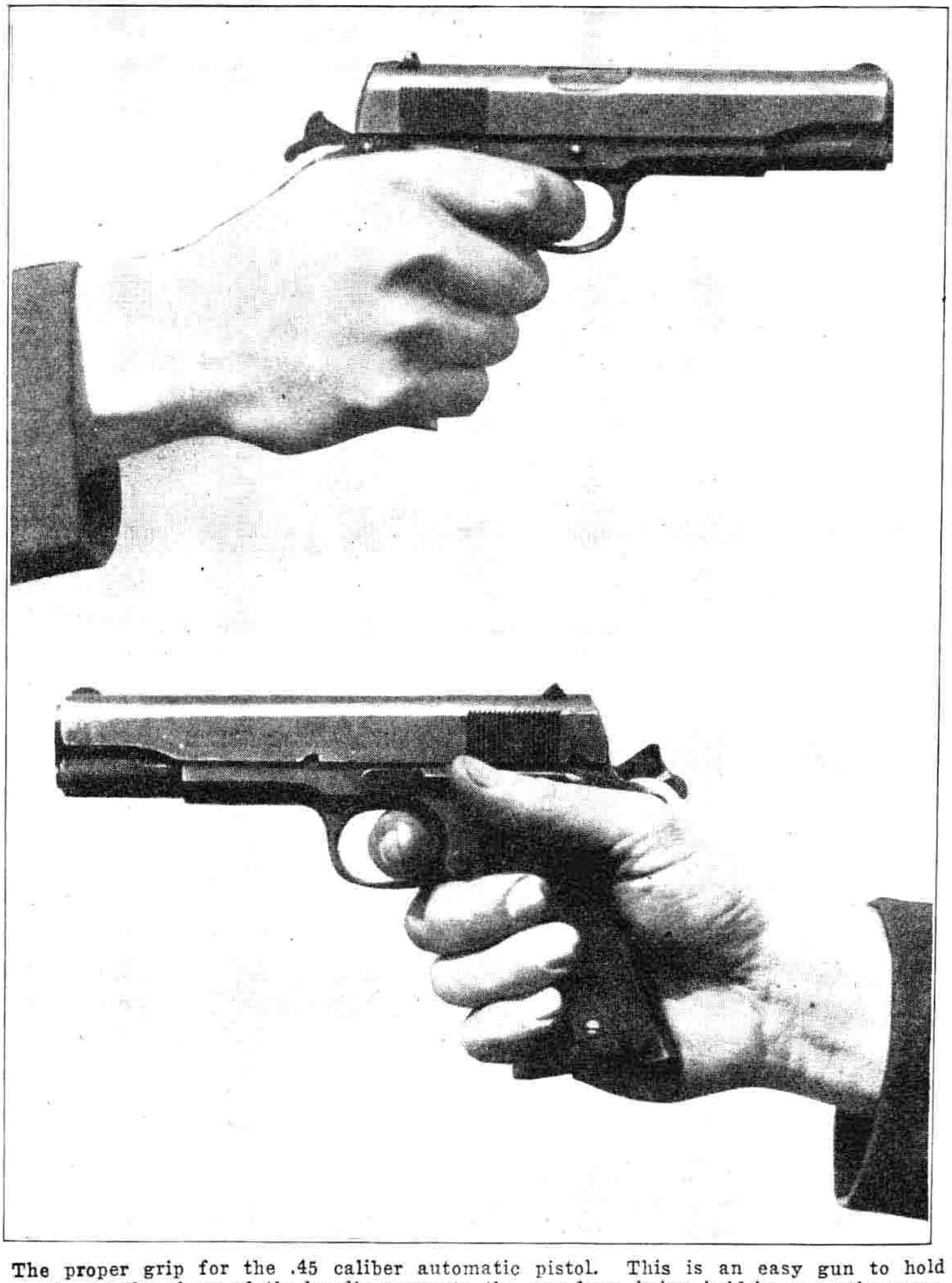
Long experience has shown that the best results are obtained if the butt is grasped as high up as the hand will go, so that the recoil will be more nearly in line with the arm than it would be if the gun were grasped lower down on the butt. Moreover, as most of the hand is on the right-hand side of the grip, the gun is supported more on that side than on the left, and consequently, the recoil has a tendency to turn the gun to the left. In order to overcome this difficulty, I prefer to place the thumb high on the frame of the revolver alongside the hammer, as this steadies the left side of the weapon more; but some well known shots prefer to cross the thumb down toward the trigger guard, and recommend that position.

Because the gun is supported only by the hand and because with all but the .22 caliber arms the recoil is considerable, it will be found that the method of holding will have a noticeable effect on the way the gun shoots. If held high it will shoot lower than if held with the hand low down on the grip. If held with the thumb laid alongside the frame as described, it will generally shoot where it is aimed; but if held with the thumb pointed downward and crossed over the frame toward the trigger guard, the gun will have a tendency to shoot higher and more to the left.

In general, no matter what type of weapon you are using, you should take hold of the gun in the most natural manner possible, and hold it fairly firmly, but do not grip it tightly, as this will cause trembling and will put the muscles under such a strain that twitching or flinching will most likely result.

With automatic pistols there is just about one position the hand can take, because the trigger guard rests on top of the middle finger and the curve of the grip at the back just below the hammer rests on top of the thumb. Hence, in general, the manner in which the modern automatic pistol is held is much more natural than the holding of a revolver, because in the automatic pistol there is no space behind the trigger guard for the middle finger to get into. The first finger goes into the trigger guard and the middle finger just below it in a natural position, so that the first finger does not have to be bent down in an acute angle in a strained position to reach the trigger as it does on a revolver. Moreover in the automatic pistol it is not possible to have the hand high on the grip one time and low the next. Also, the thumb projects straight forward along the left side and the user does not have to worry whether to cross the thumb over, as described above, or lay it alongside the frame.

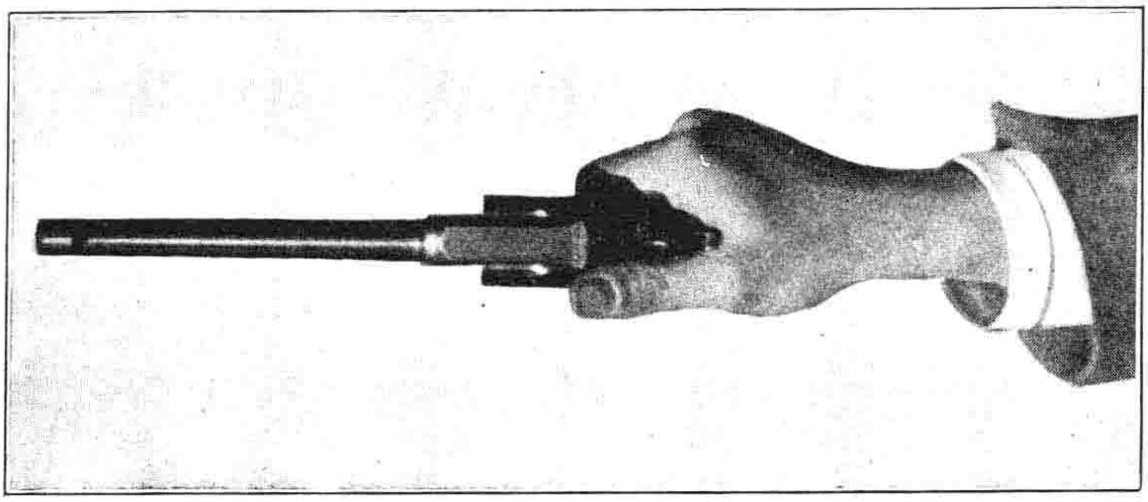
With revolvers, however, the case is different. The average revolver is not well shaped for holding, and most marksmen are



The proper grip for the .45 caliber automatic pistol. This is an easy gun to hold properly, as the shape of the handle prevents the gun from being held in any other way.

constantly struggling to find a comfortable and natural method of handling the gun. It is possible to hold it with either a high grip, that is, with the hand way up nearly in line with the barrel, or with a low grip, that is, with the hand well down on the butt the same as if you were grasping the handle of a saw. Moreover, the thumb may either be placed high along the side of the frame as shown in the illustration, or may be crossed over so that it comes down toward the top of the index finger as it rests on the trigger.

In most revolvers the space behind the trigger guard goes too high up, so that if the middle finger is placed in this space it is difficult for the first finger to get down onto the trigger without being bent out to an unnatural angle with the other fingers. A great many revolver shots fill up this space with a piece of rubber or wood cut to the proper shape and then bound onto the grip with tire tape. Such filler pieces have acquired the name of "gadgets" among target shooters with the pistol. Thus when, at the annual meeting of the Association, there was a discussion of the advisability of allowing the use of the "gadget" in certain matches, this filler piece was what was meant. Several of the later models of pistol or revolver have such a filler piece built in as a part of the trigger guard or frame, and it is expected that this tendency will become more pronounced in the future. Several such devices are described in chapter 6.

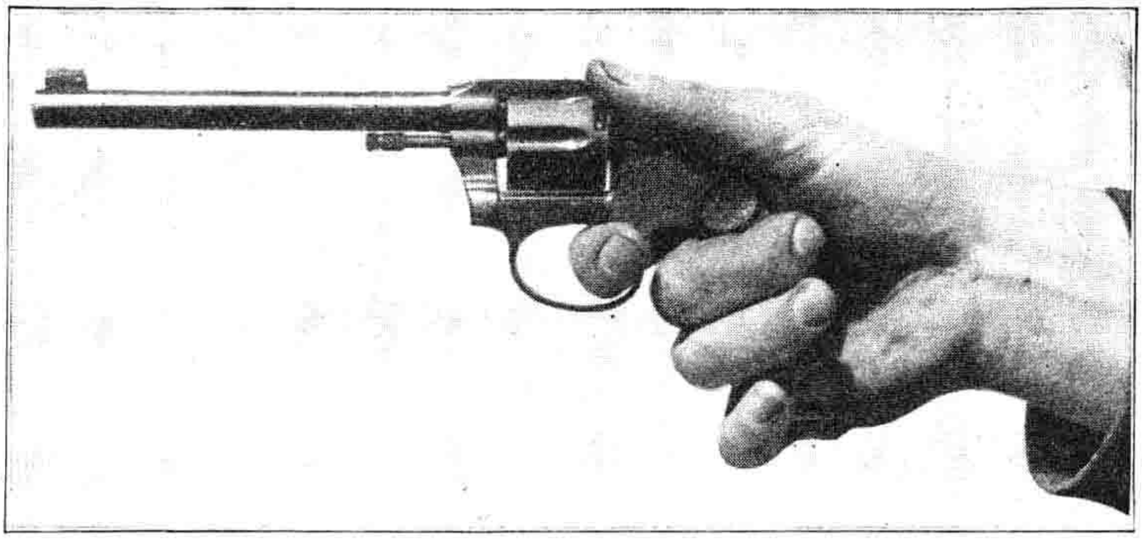


Grip the revolver so the line of sight will be in prolongation of the wrist and arm. This "beds" the weapon against the palm of the hand and the recoil is taken up squarely. Beginners invariably grasp the butt too low and too much to the right with the result that the line of bore (and recoil) is high above the hand; upon firing the recoil throws the barrel up and to the left.

All these attachments are a very great help in forcing the user to take the same grip every time. However, some shooters prefer to dispense with the gadget and instead curl up the middle finger and let it project slightly forward and allow it to support the bottom of the trigger guard instead of getting up into the space behind it.

It is desirable, of course, to avoid alterations or adjustments to your gun, such as the changes above mentioned, if you can do without them, but in any event you should be sure that you learn to take hold of the gun in such a manner that you can always quickly reach for it and have the same grip when it comes up to the firing position.

The smaller Colt revolvers (especially in the earlier models), such as the Police Positive Target, have a rather narrow oval shape to the bottom of the grip and the edge is well rounded.



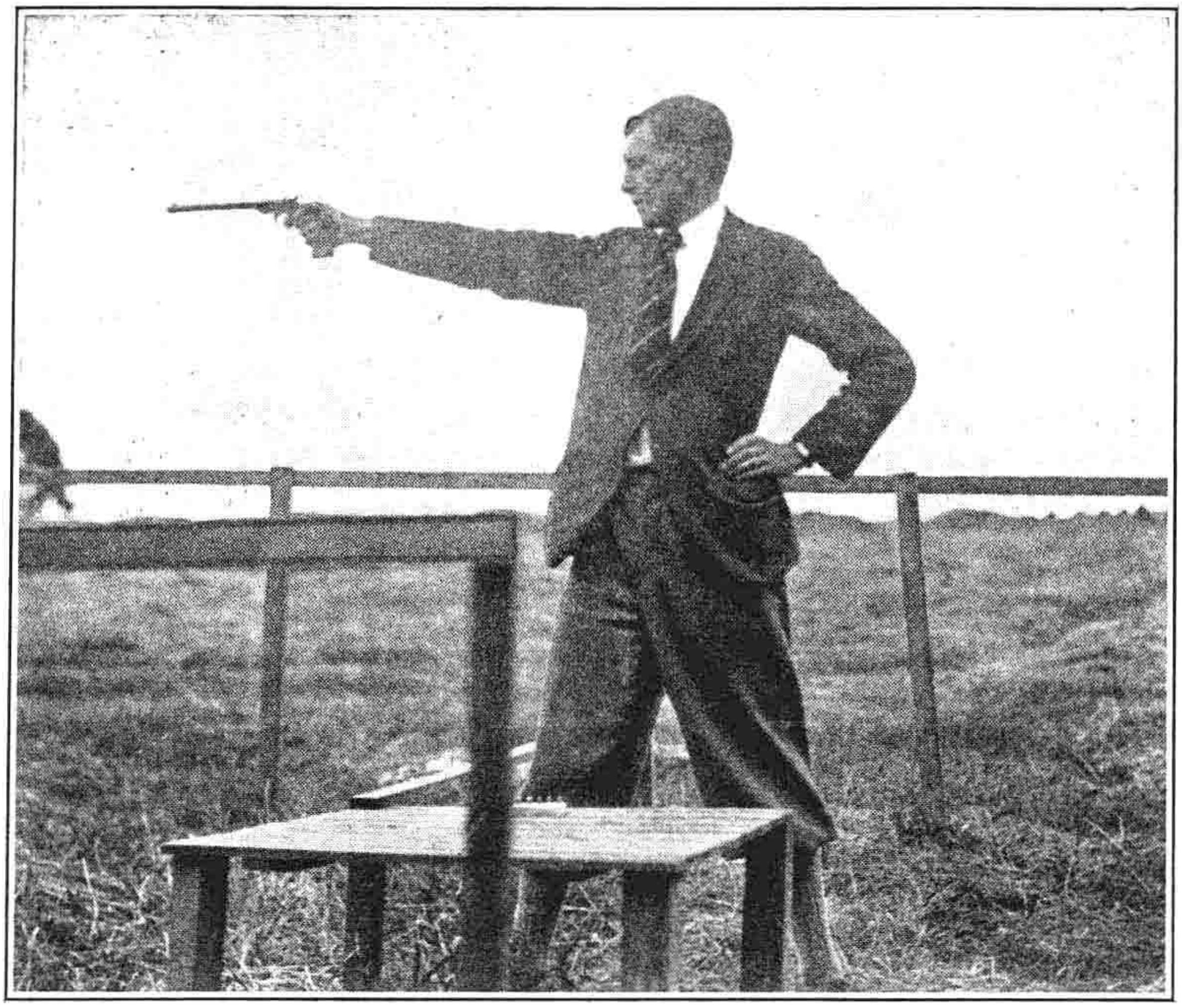
This method of holding a small revolver, or one that has a grip that is narrow at the bottom is especially good for rapid fire. The little finger is hooked under the bottom of the grip, thus preventing the hand from slipping to a new position from the jump of the gun on recoil.

With these guns it will be found quite comfortable to place the little finger under the bottom of the butt, which completely overcomes the difficulty above mentioned, as it prevents the hand from slipping up to a new position on recoil. If the gun has a fairly large handle, however, this method of holding means that a low position must be taken. In other words, it must be gripped fairly down toward the end of the butt.

We now come to the question of the single shot pistol, and here is where we find the widest variation in the kinds of grips that are allowed and recommended. In both the automatic pistol and the revolver, the method of holding the weapon is influenced to some extent by the heavy recoil experienced in the guns of larger caliber. However, as all modern single shot target pistols are made in .22 caliber only, recoil does not enter as a factor to be considered. There are some single shot target pistols such as the

Smith & Wesson Straight Line and the Stevens No. 10, that are shaped just like an automatic pistol. With these guns there can be only one method of grasping, as described above for automatic pistols.

Then there are other single shot target pistols that are made on the frame of a revolver. Examples are the Smith & Wesson Perfected Model and the Colt Camp Perry Model. These may be grasped either high on the stock behind the hammer, or low; the thumb may either be laid alongside the frame or crossed down toward the trigger finger; a gadget may be used or not according to the fancy of the user. But in general, the method of holding these guns is the same as that of holding the revolver.



Typical British shooting position as seen on the small bore pistol range at Bisley. Mr. B. Cooper, of the Imperial College Rifle Club, London, shooting his Webley Target Pistol.

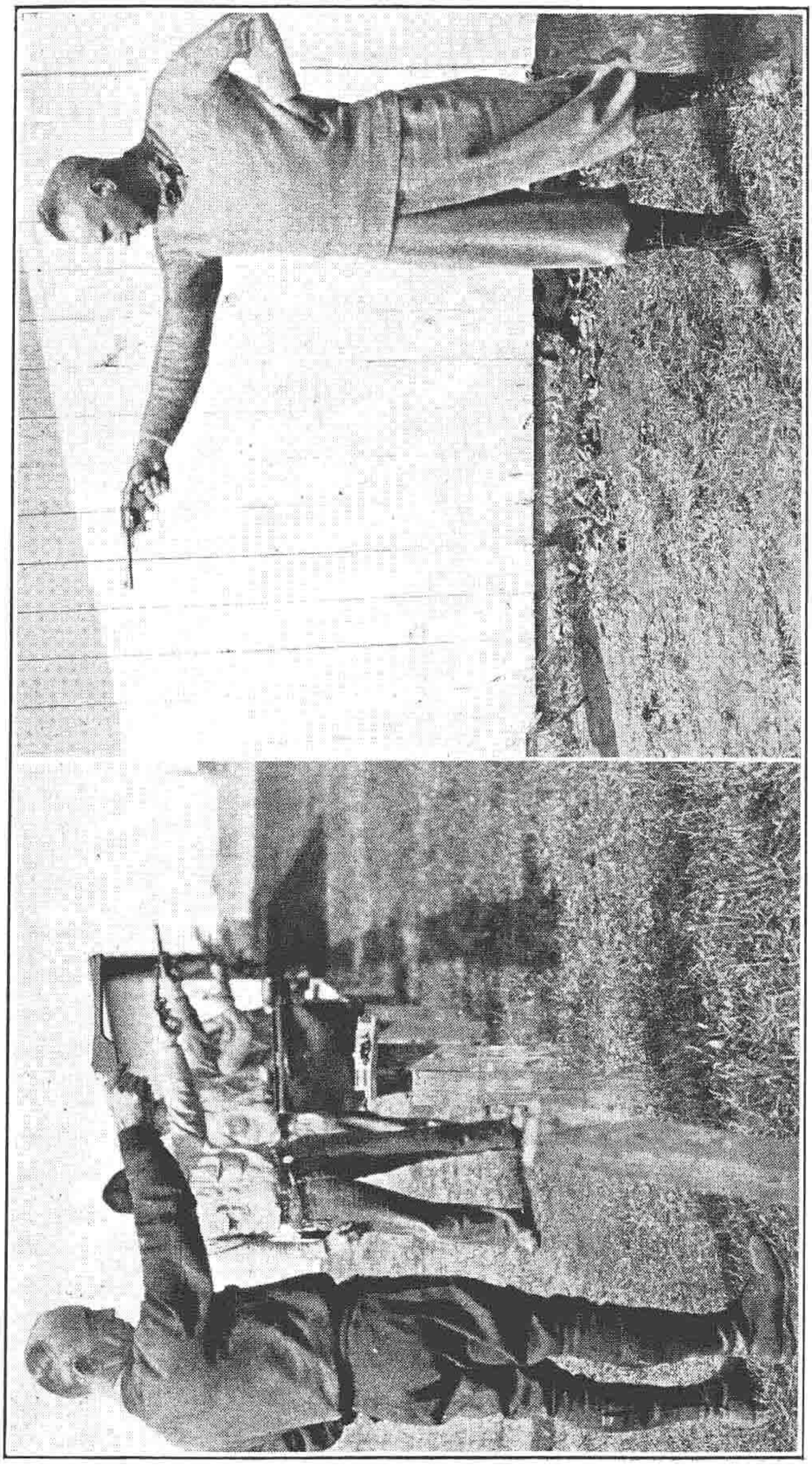
There are, however, several other single shot target pistols which are shaped entirely differently from either the automatic pistol or the revolver. Among these may be mentioned the Stevens Off-Hand Model and the Webley, which have curved handles somewhat like those of a revolver; the free pistol such as the Tell and Widmer Models which have massive grips especially shaped for some special method of holding; and the Harrington & Richardson Single Shot Pistol which is shaped very much like a revolver but has some important differences which render a distinctive method of holding possible.

In connection with the matter of gripping a single shot pistol, we have two distinct schools of thought; one which favors having the hand and wrist in a neutral position when shooting as is always the case when shooting an automatic pistol; and the other which believes in using a nearly straight grip, so that the wrist may be bent down sharply and put in a tense position while shooting.

The advocates of this latter position claim that the use of the neutral or automatic pistol position of the wrist is conducive to tremors. The wrist is a free universal joint which can be moved in any direction, and the only thing that holds it in one position is the balanced tension of the different sets of muscles. When grasping a pistol and pointing at the target with the wrist in the neutral position, especially if the pistol is balanced about the center of the hand, there is one set of muscles on top of the arm which pulls with certain tension to keep the muzzle of the pistol high enough, while the other set of muscles underneath the arm pulls at certain tension to keep the muzzle of the pistol low enough.

原书缺页

原书缺页



Left: On the firing line at Camp Perry, 1931. Mr. George H. Keyes, of Boston, an outstanding pistol shot of today is seen in the foreground.

Right: A good shooting position. Posed by Mr. R. C. Bracken, of Columbus, Ohio, an excellent pistol and revolver shot.

first and second fingers and thumb are used; the other fingers can be allowed to rest lightly against the stock, and this forms an extremely comfortable and steady hold.

Moreover, the advocates of allowing the joints to do the work instead of balancing one muscle against another, also utilize the elbow by first turning the arm with the palm of the hand upward, which brings the elbow down. Then by straining the arm out as straight as it will go, it will be found that the elbow will lock; that is, the joints will come together and cannot be bent any farther in that direction. Holding the arm like that, turn just the hand over until the thumb is on top, then you will have both the elbow and wrist locked in a rather immovable position, not depending on muscular effort to keep them from bending farther.

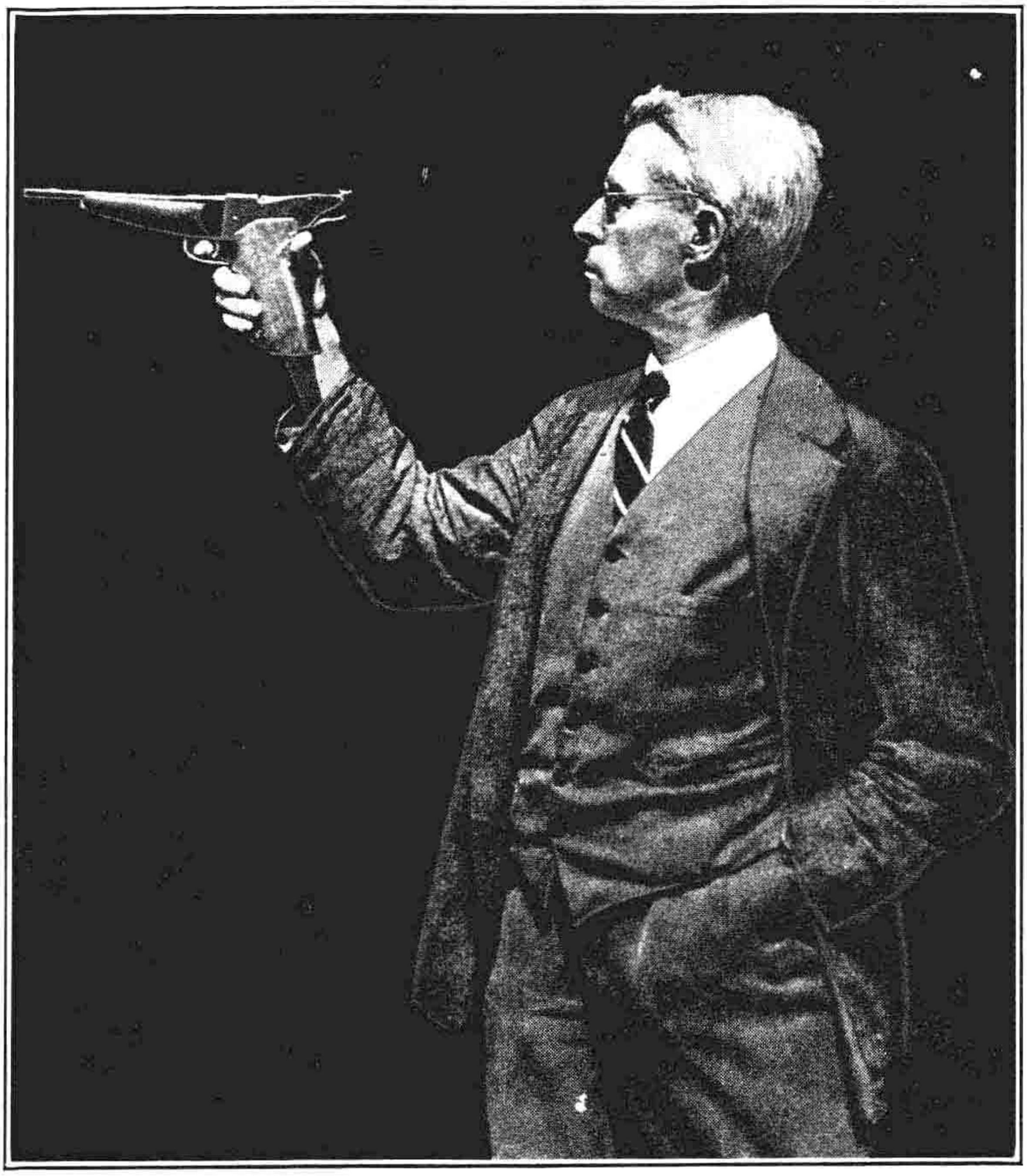
The proponents of this position go still further. They face a good deal farther to the left so that the shoulder is thrown around as far to the right as it will go. This also has a tendency to lock the shoulder joints The advocates of this position claim that the human shoulder and elbow are like the center joint and one of the end joints respectively of a folding two-foot rule which can just be bent only so far to the right and so far downward until they come to a locked position.

While a study of the orthodox position will repay the beginner, it is well for him to remember that there are many positions which have their strong advocates.

At the International Matches in Antwerp, Belgium, in 1930, everyone observed one particular shooter who had a very striking position. He held the gun with his arm very much bent so that the butt of the gun was just about a foot from his eyes. I heard several people remark that he used such a peculiar position that he undoubtedly did not know much about shooting. When the matches were over, however, he was the champion of the world, having won first place with apparent ease. This shooter turned out to be Mr. Revilliod De Budè, of Geneva.

It is quite possible to get most excellent results with these extreme positions, but I believe that the easiest and most natural way for the beginner is to take such a position that the pistol can be aimed at the target in the easiest and most natural manner possible. Moreover, the straight arm position has an advantage over the bent arm position in that the farther from the eye the pistol is held, the clearer will be the definition of both sights and the bull's-eye when they are viewed at the same time.

The eye really has quite a job to focus on those three widely separated points, that is, the rear sight, front sight, and bull's-eye, and still get them so that they all appear clear. In many cases it is not possible to do this when the shooter is advanced in years and the power of accommodation of the eye has weakened somewhat.

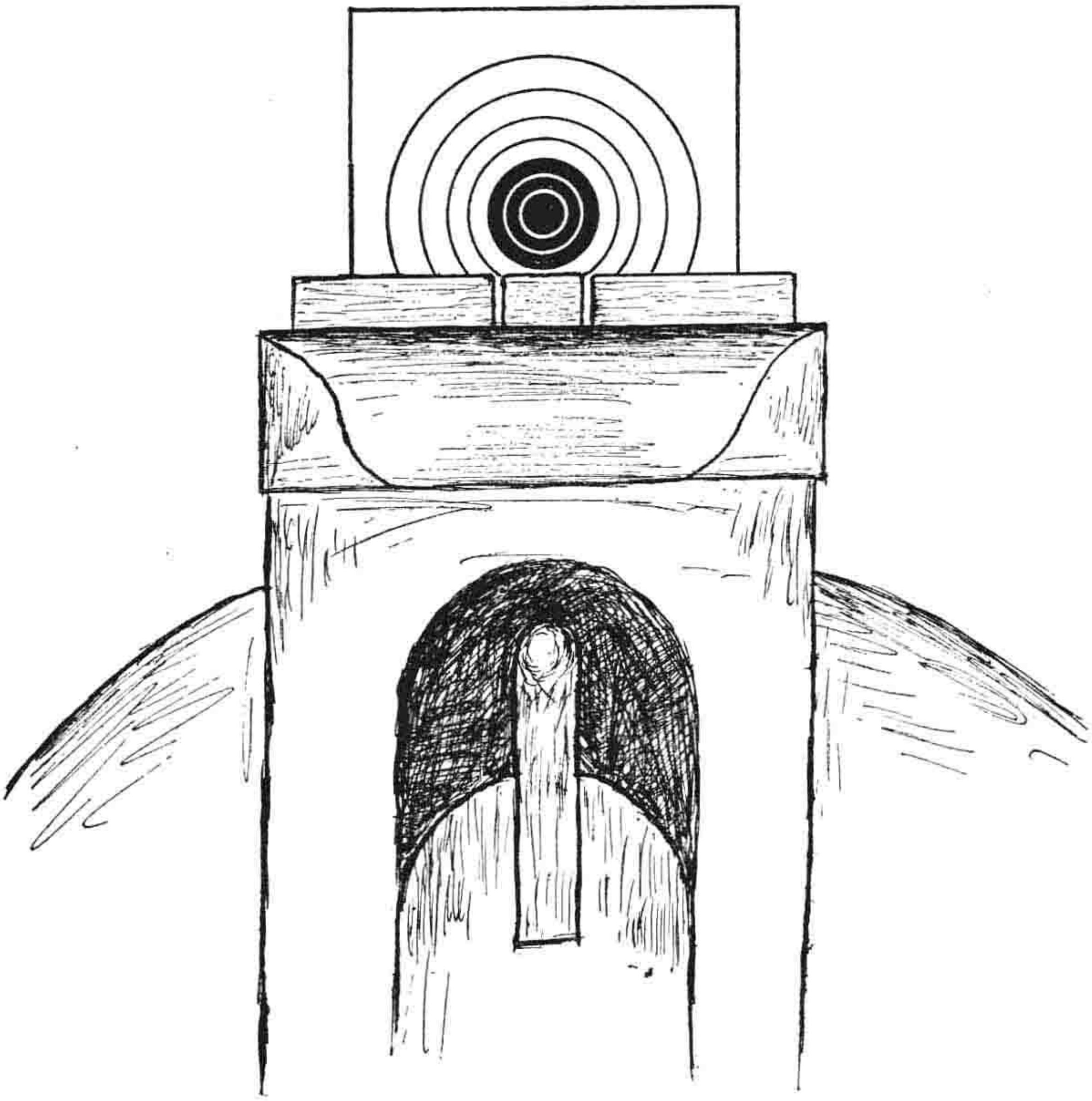


Shooting position of Monsieur A. Revilliod de Bude, of Switzerland, who won the Pistol Championship of the World at Antwerp in 1930. The author, who was present on that occasion was much interested in the unusual weapon, grip and shooting position of M. Revilliod, and with his kind permission took several photographs.

The optical difficulty will bother some shooters but experience has shown that if this apparent blurring of the sights is ignored as much as possible, the best results will be obtained as the eye will automatically tend to center the sights even if they appear slightly blurred.

Sighting

After learning to stand correctly and to hold the gun properly, the next thing to do is to learn how to use the sights.



Appearance of sights and bull's-eye when aiming at the Standard American Target at 20 yards. This sketch was made with great care to show the actual relative size of the target and the sights. Gun is the Smith & Wesson .38/44 Outdoorsman's Revolver.

Pistols and revolvers all have open sights. The rear sight consists of a bar with a notch in it, and the front sight consists of a blade or bead. In target shooting, the front sight should be brought into the center of the notch in the rear sight, and the top of the blade or bead should be just level with the top surface of the rear sight, and should be brought exactly under the bull's-eye, so that the top of the front sight appears to just touch the bottom of the bull's-eye. This is what is called a "six o'clock" hold, because it is pointing just at the place where the six o'clock figure is located on the dial of a clock.

Most beginners think that it would be better to point right in the middle of the bull's-eye, but this is not so, because the bull's-eye is black and the front sight appears black when it is looked at at arms length and if you put it in the middle of the bull's-eye, you cannot tell just where it is pointing or whether it is in the middle of the notch in the rear sight.

However, if you point under the bull's-eye, the white paper makes a background for the sights and you can readily see that you have the front sight pointed in the right relation to the rear sight, and moreover, you have both sights properly aligned in relation to the bull's-eye itself.

Most beginners think that if you aim at the bottom of the bull's-eye, the bullet will hit at the bottom, but with adjustable sights a correction will be made so that shooting at the bottom will cause the bullet to go in the middle.

Most people think that in aiming a gun they must shut one eye and keep the other open. It is quite true that one eye does do all of the sighting but it is best if the shooter can accustom himself to it, to shoot with both eyes open, as this will help a great deal in avoiding eye strain. If the shooter cannot do this at first he can learn to do it by wearing a pair of glasses and hanging a cloth over the left eye until he becomes used to keeping this eye open also. Shutting one eye while keeping the other open causes squinting which puts a strain on the muscles and is hard to keep up for a long time as in a match, and it will be found perfectly easy and natural after a little practice to shoot with both eyes open.

You do this in a way when you point your finger at any object. There are really two images of your finger but mentally you disregard one of the images. Just try this some time: Point your finger at some object, then close first one eye and then the other and you will see that there are really two fingers apparently pointing in two directions but you have only taken mental note of one of them, and it is the same when sighting with both eyes open.

Some people want to sight with the left eye and some with the right eye. There is one eye that unconsciously dominates the other. This is called the master eye. You can quickly find out whether your right eye or left eye is the master eye by the experiment described above, by pointing a finger at some object and first closing one eye and then the other. The eye which sees the finger pointing at the object is the master eye and the eye that sees the finger apparently pointing somewhere else is the subject eye.

A very good exercise which would teach the proper methods of sighting and at the same time eliminate, as far as possible, the errors which arise in this way, is the making of sighting triangles. To do this the gun is rested on a bag of sand or sawdust on top of a tripod or step-ladder at a convenient height for the shooter's eye, and is aimed at a movable black disk, which represents a bull's-eye. Once the gun is aligned it is left without changing its position, and the man who is helping you goes to the target point and takes hold of the handle of the black disk above mentioned. This disk is generally cut out of tin, painted black, and is the same size as a bull's-eye and has a hole in the center of it just big enough to admit the point of a pencil. A white sheet of paper is pinned over the target, and the man who is practicing aims without touching the gun, at the same time motioning to the one who is helping at the target, indicating to him the direction in which he ought to move the black disk.

When the assistant has the disk in exactly the proper position so it appears just right to the marksman when he is looking over the sights, he calls out "mark," and the assistant then marks through the hole in the center of the black disk, making a dot on the paper. He then moves the disk away and the process starts over again. Of course, if the marksman were absolutely accurate and had perfect eyesight the two marks would be on top of each other, but in practice this is never so, as there is always a slight error in the aiming and the marks fall a short distance apart.

When three of these marks are made they are joined by lines and form a little triangle, which gives an indication of the error the marksman has made in getting the bull's-eye lined up with the sights. This error varies with the eyesight and judgment of the marksman, with the lighting conditions and with the kind of sights used.

This exercise is an excellent one to teach a shooter what kind of sights are best suited to his eyes. It is perfectly obvious that if his successive positions with the sighting disk are, for example, three inches apart, he cannot expect to get a half-inch group when he starts shooting, even if the gun were absolutely accurate.

Another thing to do about sights is to study the adjusting of them, learn which way to move the sights to make the bullet move the way you want it to go. This has been described in another chapter under the heading of sights.

Snapping Practice

The next step after learning how to sight is to practice snapping and aiming at the target without any cartridges in the gun. This practice can very well be carried out in your bedroom, cellar, or almost any place where there is proper light. It is not necessary to have a regular pistol range, nor is it necessary to have a regular target. Any round black spot on a white sheet of paper will do as an aiming point.

Some effort should, however, be made to get the same relative size as the bull's-eye of the target would be if you were aiming on a regular pistol range. Bear in mind that the bull's-eye is 2.72 inches in diameter at 60 feet. You can easily make an aiming mark that will be the proper size to use at 10 feet or any other desired distance.

When you are ready to start this practice, always examine the gun to be sure that it is empty. Then take the proper standing position, cock the gun, point it toward the target and squeeze the trigger carefully until the hammer falls. At the same time watch the sights carefully to see if they move on the target at the moment the hammer falls. If the sights do move when the trigger is squeezed, it shows that the shot would not have gone true.

With some guns it will require a considerable amount of practice and quite a bit of experimenting with different holds and grips before proficiency can be obtained in this "dry shooting." It is an interesting test of steadiness to balance a dime on the barrel of the gun just behind the front sight and see if it has a tendency to fall off when the hammer is snapped.

Quite a bit of practice may be necessary before the marksman learns to hold the gun absolutely steady when he lets the hammer drop. When this point has been attained, the marksman has reached such a stage that he would be able to hit the bull's-eye if a cartridge were in the gun when he pulls the trigger.

Here it may be stated that no properly made, modern weapon is injured by snapping without cartridges in it. Some cheap .22 caliber rifles are made so that the striker hits the metal of the barrel when snapped without a cartridge, but long ago American gun makers recognized the fact that a real gun enthusiast will wish to snap his weapon for dry practice, and accordingly all the better guns are made so that the striker does not hit the metal of the barrel when snapped.

The beginner may wonder why we start to learn to shoot without using cartridges. The reason is simple. The first thing to do is to learn to snap the gun in such a fashion that the aim is not disturbed. It might be thought that this could best be accomplished by actually shooting at a target and seeing if the bullet hits the point aimed at, the assumption being that if the bullet does not hit the point aimed at, the shooter did not snap the gun in such a careful manner as to avoid disturbing the point of aim.

This is the way many shooters first learn to shoot, but it has the very serious disadvantage that when a gun is actually fired there is recoil, noise, and flash, each of which produces something of a shock to the nervous system, especially when the nerves are not accustomed to these effects of firearms. A new shooter just starting to learn, who is trying to pull the trigger carefully, cannot put his mind at ease and concentrate on the trigger squeeze if he knows that the moment he squeezes hard enough to make the gun go off there will be a tremendous report and big kick; his nervous system will be all on edge waiting for the noise and the kick. The result is that he is likely to make up his mind and then suddenly jerk the trigger, or flinch. When he does this he actually makes the gun go off and the kick of the gun masks or hides the flinching and he never knows that he has done anything wrong. Under these conditions the shots may go in the most unaccountable places for no apparent reason.

If the gun could actually shoot a bullet without making any noise or recoil, it would be an advantage to use the target and shoot at it even in the first practice.

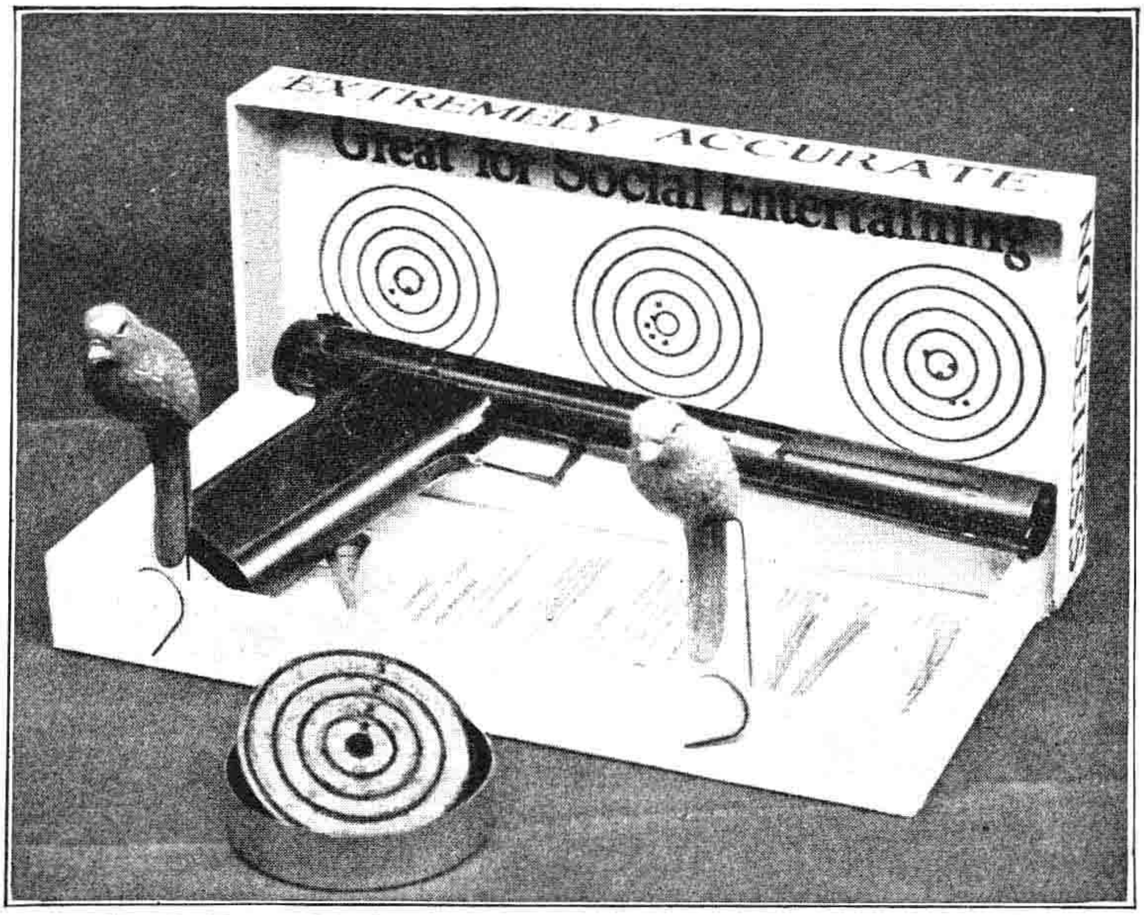
The Bull's-Eye Pistol

There is a gun on the market that does shoot a bullet very accurately without making any noise and without having any recoil. It is a toy called the Bull's-eye Pistol, which is made in the same shape as an automatic and shoots a No. 6 chilled shot by the aid of a rubber band.

This gun is extremely accurate at ranges of not over ten or fifteen feet. In the outfit with it are several small celluloid birds of the ordinary ten-cent store variety, and some wire perches for these birds arranged to clamp on the front edge of the box. The user is supposed to set these up at a distance of ten feet or so and then try to knock them down by shooting at them. The back of the box catches the shot that miss the birds.

While the Bull's-eye Pistol shoots hard enough to knock down these birds or make a small mark on the pasteboard target, or to kill a fly, it does not shoot hard enough to break an electric light bulb or to put out an eye, though it is certainly advisable to use every care not to point the pistol at anyone because it would, of course, be far from pleasant to be shot in the eye with it even though the bullet would not have enough velocity to penetrate.

A few years ago I gave one of these pistols to my two young sons, and without giving them any instructions except in safety precautions, let them practice with it a week or two. They soon became very proficient in knocking down the birds and naturally there was no tendency to learn the flinching habit because nothing startling happened when the trigger was pulled; the only thing that happened was that sometimes the birds fell down and sometimes they did not. After a week or so the boys got so they could hit the birds every time with this pistol, and just for the sake of an experiment I took them for a walk and let them try my 10-inch target pistol with regular .22 caliber cartridges. Various targets were used, bottles, tin cans, etc., and a miss was a very rare thing indeed. Firing at the Standard American Target at the regular distance, they made fair groups.



The Bull's-eye Pistol with complete outfit of targets and "gallery"

A week later an impromptu target competition with automatic pistols was held at the request of a group of Army Reserve officers who were on fifteen days' annual duty. Among this group there were several men who were well qualified in pistol-shooting, and they suggested that the target be placed at half the regular distance, so that those members who were not familiar with shooting would not be utterly discouraged by missing the target 100 per cent.

In spite of this arrangement a large percentage of the shots fired by this group of officers (with exception of the two mentioned) missed the target entirely.

The reason that the half-grown boys did so much better than these officers was because they had been allowed to learn to shoot in such a way that they did not anticipate a disturbance every time they pulled the trigger.

Another very interesting thing that I observed in using this Bull's-eye pistol was its effect on a large and very intelligent police dog which had a decided dislike for the report of a gun. One day an acquaintance who was visiting me picked up this Bull's-eye pistol and began shooting at the birds, and I noticed that each time he aimed at a bird the dog would watch him very attentively and would start violently just before he pulled the trigger. After noticing this, I watched very carefully and I could not tell just when the trigger was to be pulled, but evidently the dog could. The dog, being sensitive to the discharge of firearms had evidently watched people shoot and learned to detect the moment when the shooter had made up his mind to pull the trigger.

If it requires such a nervous effort on the part of a marksman to bring himself to the point of actually pulling the trigger that this effort is visible to a dog, it is quite apparent that the tensing of the muscles which results from this nervous effort will have an effect on the marksmanship. This can be very well observed in target-shooting by loading one chamber of a revolver with an empty cartridge and the others with loaded ones, unknown to the firer. If he is flinching you may not be able to detect it, and he may not be able to detect it when a cartridge goes off, because the motion of the flinch is masked by the recoil of the gun, but when he comes to the empty cartridge he will flinch just the same, and then it will show up in a ridiculous manner, which will generally cause him to make a conscientious effort to overcome the trouble.

Frequently I have had a man complain that the gun was inaccurate or was improperly sighted, or state that he had to aim at the top right-hand corner of the target to hit the bull's-eye, and almost always these claims can be traced back to this flinching

原书缺页

原书缺页

a number of bullets hit in the same place. The advantage of having the wall there is if a bullet should accidentally miss the backstop behind the target, the wall would prevent it from going where it would do any great harm.

Never make the mistake of tacking a target onto the wall of a wooden building, and then shooting with the expectation that the wall will hold the bullets. I once knew of a man who purchased a .22 caliber rifle and decided to do some target practice. He knew nothing whatever about shooting or the properties of firearms, so he tacked a target on his neighbor's garage and fired quite a few shots at it. When he took the target down he found a series of holes in the door where the target had been tacked, and then he began to wonder just how far the bullets had gone, so he looked inside and discovered that they had gone through the door and had penetrated the back of a sedan car which was sitting inside. The neighbor happened to be away, so this man without saying a word about it, had the automobile taken out of the garage, repaired and put back in the garage before the owner reappeared. The neighbor never would have known what happened had not the shooter gone to him and told him what he had done. This is one case where a lack of even a little knowledge of the precautions necessary with firearms cost the shooter a great deal of money.

In the less settled parts of the country it is usually easy to find a safe place to practice, and while the problem is more serious for city dwellers, there is usually available in or near the larger towns and cities a club affiliated with the U. S. Revolver Association or with the National Rifle Association, and these clubs will have the necessary facilities for safe target practice. The beginner can do no better than to join one of these clubs where he will find not only a place to practice, but also people able and willing to give advice and information.

The first actual shooting is best done at a target rather than at some object selected as a mark to shoot at. The reason is that the target provides a clearly defined objective to aim at and makes it easy to take the same aim every time. Thus any errors may be most easily detected and overcome by using the target. Moreover, it is advisable to stick as closely as possible to the targets and distances which are authorized in the regular target shooting rules, because sooner or later you may want to enter a target competition even though that is not your object in learning to shoot pistols and revolvers.

In an American target competition there are two types of shooting; outdoor and indoor. The outdoor shooting is done at fifty yards on the Standard American Target which will be described here briefly. This target has a black bull's-eye, eight inches in diameter, with rings both inside and outside of it for counting the score. Indoor shooting is always done at twenty yards and by artificial light. The target for indoor shooting is the same as that used for outdoors except that the rings are reduced in size, the bull's-eye being 2.72 inches in diameter.

The author shooting his 8 inch barrel Harrington & Richardson in 1931 at Bisley, England, where he was winner of the Webley & Scott Pistol match with a perfect score of 100. A perfect score has been made on one previous occasion, which was some years ago, and the author's winning score thus ties the British Empire Record for this ten shot match at 20 yards outdoors.

When the shooter has at last reached the stage of placing himself in front of a target on a safe range in preparation for shooting with actual cartridges, it is preferable at first to load the gun with only one cartridge at a time whether using an automatic, a revolver, or a single-shot pistol. Thus, each time the gun is fired it will be perfectly safe because the only cartridge in it will have gone off and the inexperienced shooter will not have to think about having a loaded gun in his hand. He should use just the same precaution as though the gun were loaded to its full capacity but the chances of accidents will be greatly minimized.

After loading extend the arm toward the target and sight under the bull's-eye in exactly the same way as is done in dry shooting. Each time the sights come in line with the required point at six o'clock, tighten the squeeze on the trigger slowly, increasing the pressure as long as the sights remain in the proper place: but as soon as you swing away from this place do not put any additional pressure on until you bring the gun back in line again. In this way you will tighten up the pressure on the trigger whenever the gun is properly lined up and you will never know just when it is going off, because you only tighten it up a very little bit at a time. If you never tighten up your squeeze except when you are lined up properly, it stands to reason that the gun will never go off except when lined up properly. Also, what is more important, if you never tighten up your squeeze enough at any time to be sure you are going to make the gun go off at that instant, you will never flinch, because you cannot flinch without knowing just when the gun is going off.

In firing this way, always keep the eyes open when the shot goes off and try to observe exactly where the sights are on the target at the moment that the discharge occurs. This, in itself, is a great help against flinching, as the man who flinches closes his eyes at the discharge and has no idea where the muzzle of the gun was pointing.

In the first practice always keep the same point of aim. If the shot strikes high do not aim low, so as to correct it. The first thing to do is to learn to make a good group. Always aim just the same and then you can see how good your group is. If the group is not on the bull's-eye it can be brought there later by adjusting the sights or changing them if they are not adjustable. When you have learned to make a really small group on the target, you have mastered nine-tenths of all the difficult part of shooting.

At first, it is better if the shooter does not see where his shots are going, because in that way any tendency to correct the point of aim in accordance with where the last shot went will be overcome. Simply fire five shots; then go down to the target and see if they made a good group, and strive constantly to improve this group until you get it as nearly perfectly as possible.

After shooting a few shots with actual cartridges, it is well to again try the snapping exercises to see if you can still hold on the bull's-eye and snap the gun without making the sights move when the hammer falls.

Changing the Sights

After having learned to group your shots satisfactorily, the next thing to do is to change your sights so as to bring the group onto the bull's-eye.

Most of the heavy caliber weapons with fixed sights are targeted at the factory, and the sights are made to gauge in such a way that when the average shooter, holding the gun correctly, fires it with a six-o'clock hold the bullet will go in the bull's-eye. Not every gun is actually fired in the factory to see if this is so, but one out of every so many guns is actually fired in the hand without any rest, by an experienced targeter, and gauges are made which will insure the front sight always being of such a height and of such relation to the rear sight that the shots go in the right place.

You hear of many people who say that a gun will not shoot into the bull's-eye with them and they have to change the sights in one way or another, but it is a fact that the longer a man shoots a revolver the more he will find that any time he picks up a Colt or Smith & Wesson revolver and shoots it he will find it is targeted just about correctly.

With target weapons which have adjustable sights, it is easy to experiment with sight changes and with placing your shots on the bull's-eye.

To move the shots on the target move the rear sight in the direction in which you want the shots to go. Smith & Wesson target guns have a rear sight movable for both elevation and windage, whereas the Colt guns have the rear sight movable for windage and the front sight movable for elevation.

The front sight must be moved opposite from the direction you want the shots to move on the target; that is, if you want the shots to go up, you must lower the front sight, and vice versa. You can readily figure out from the length of your barrel and the distance to the target how much you will have to move your sight to make any given correction in inches on the target. For example, if the distance from the rear sight to the front sight is 6 inches or ½ foot, and the distance to the target is 20 yards, which is 60 feet, the shot will move 120 times as far on the target as you move the sight. Moving the sight .001 inch would move your group on the target one-eighth inch.

In chapter 5, under the heading of "Sights," some figures on the various weapons are given to which the reader is referred for details.

It is very helpful in adjusting sights to make a duplicate of the 20-yard target out of celluloid, drawing in the rings with India ink. After shooting a group on the target this celluloid transparent target is laid over the real one and shifted about until it comes as near as possible over the center of the group. Then measuring with a rule both vertically and horizontally from the center of the transparent target to the center of the real one will give you the amount the shot group must be shifted in inches to be centered on the real target.

With guns which do not have adjustable sights, the only way to change the point of grouping is by changing the location of the front sight either by bending it to one side or the other slightly, or by filing it off. If the groups go too low, filing the top of the front sight will raise them. If they go to the right, bending the front sight to the right will shift them to the left, and vice versa. This changing of fixed sights should never be done until you have enough experience in shooting to know that your point of grouping is not going to change.

You will note that I have not explained how to make the sight group go lower. This is, of course, more difficult than filing the sight off to make it go higher, because you must in some way put metal onto the top of the front sight. Sometimes this is done by laying the front sight flat on a hard surface and peening or pounding it with a hammer until it gets higher on account of spreading out from the hammering. This has the disadvantage of making the sight thinner at the same time, and unless you are skilled in using the hammer you are likely to make a messy job of it. A method that is superior to this is to file the front sight down to a fraction of its height and then make a new front sight, which is slotted at the bottom and pinned on over the old front sight.

It may occur to the reader that the most logical way to make the shots go lower would be to file down the rear sight. Unfortunately, this cannot be done on most revolvers, because generally the rear sight is a groove in the frame of the revolver, and the frame cannot be filed down. I have known shooters to attempt to lower the shot group by merely deepening the notch in the rear sight. This is, of course, not effective if the sighting is done in the proper way, by lining up the top of the front sight with the upper line of metal of the rear sight. If, however, the user takes what is called a "fine" sight, where the tip of the bead is just barely visible in the rear sight notch, deepening the rear sight notch will help.

One thing to remember about sighting-in a revolver is that this is a job that you must do for yourself. No one else can satisfactorily do it for you because no two people hold the gun exactly alike and there is bound to be some difference in the way it groups when fired by another marksman whose hold and eyesight differ.

Another thing that you must remember in changing sights is that there is a difference in the way the gun shoots in artificial light and in natural light. Generally a gun sighted-in in a shooting-gallery in artificial light will shoot higher when taken outdoors, though sometimes the reverse is true, depending on how the lighting is arranged in the gallery. Bearing this in mind, you will sight-in any target guns that you intend to use for indoor shooting under the actual conditions that you intend to shoot under, and, of course, if in the future you use the gun outdoors, it is an easy matter with target sights to change back. However, with guns having fixed sights, it is another matter entirely and you must make up your mind how you are going to use the gun before you alter these sights.

In slow-fire matches, it is the practice to have a telescope on the stand near the shooter, and after each shot he will want to look through the telescope to see where the last shot went, and if several shots, for any reason, are going in one direction and not in the bull's-eye he will probably want to change his sights. It should be noted, however, that it is almost fatal to match accuracy to change the sights for each shot, for if anything happens to disturb your aim and make the shot go, for example, to the right and then you change the sights to bring it back again, it will go to the left because the accident that made it go to the right before is not present.

An experienced target shot knows that after getting his sights once adjusted so that the bullets are going into the bull's-eye, he should be very slow indeed to change it. This is especially true of those shots who are at all inclined to be nervous in entering matches, or, in other words, who get what is called the "buck fever." A man like this may shoot for weeks and group into the bull's-eye perfectly, but the first shot or two of the match will be fired under a nervous strain and he may throw his shots one way or the other until he steadies down. If he uses the telescope and changes his sights for every shot he will become hopelessly confused.

The same thing applies to shooting in the wind. When you first go to shoot outdoors in a puffy wind, you will find that it will bother you quite a little, as your gun seems to sway all over the target; but if you will tighten up on the trigger only when your gun swings under the bull's-eye you will find that your scores will be pretty good.

For shooting in a wind, it sometimes helps to face the target more than you normally would, as it prevents the body from swaying so much.

After having learned to shoot satisfactorily with a .22-caliber weapon the next thing to do is to change to larger calibers. It will be found that there is very little difference, and if you do not let the expected heavier recoil make you flinch, you will get just as good results with the larger calibers as you did with the .22.

In fact, in target-shooting, the same degree of holding will give a larger score with big calibers than it will with the .22, because the large-caliber hole covers more territory on the target and therefore will frequently cut into a ring of higher count that would not be touched by a .22 whose center was in the same spot.

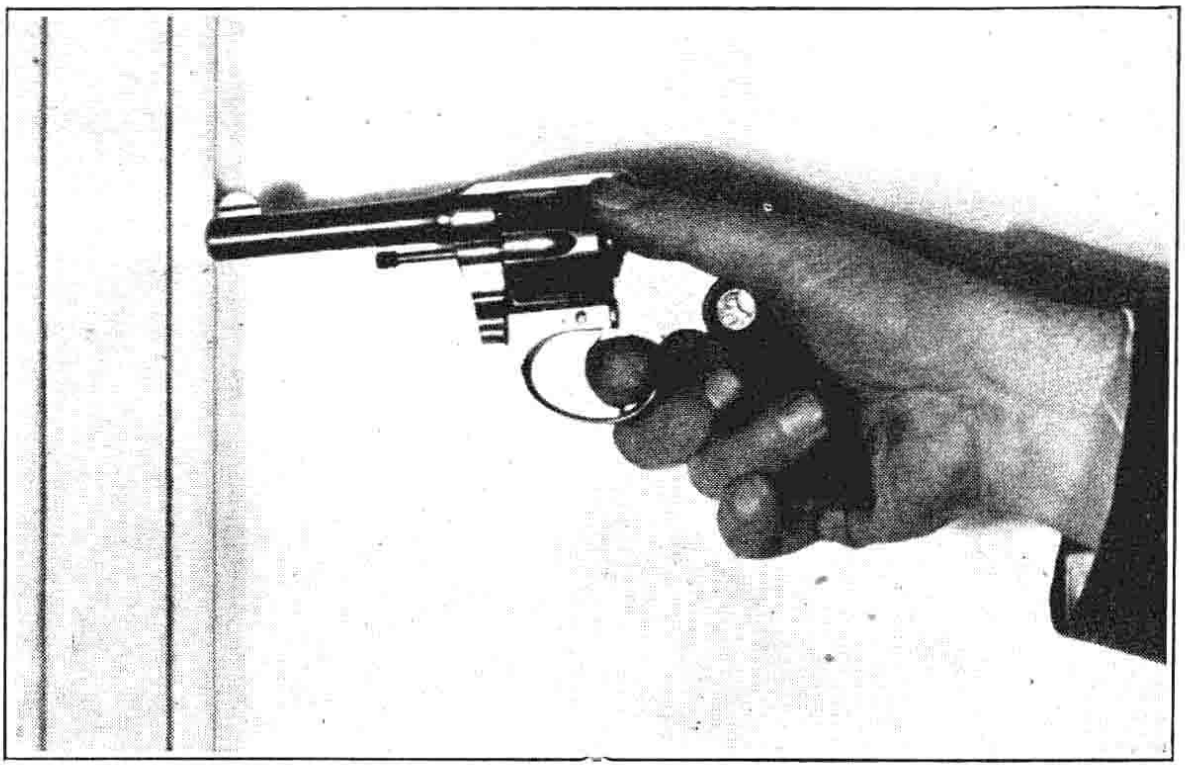
Rapid Fire

It will be found that after the principles of slow fire have been mastered, as described above, it is not very difficult to increase the speed at which the shots can be let off, at the same time squeezing the trigger only when the sights are lined up with the target.

Really excellent scores with rapid fire require a great deal of practice to get the gun lined up quickly and at the same time squeeze the trigger with sufficient force and not cause the gun to deviate; but the principles are exactly the same as described under slow fire.

The best way to accomplish rapid fire is to cock the gun for each shot and not attempt to use double action, though some skilled shots have made excellent scores with the double-action method. At first it seems hard to cock the gun and shoot it five times in 15 seconds, but with a little practice without cartridges in the gun it is surprising how quickly speed can be acquired.

A great many years ago, when I first entered the Army qualification matches with the old .38 revolver, I found difficulty in shooting five shots in 10 seconds, as was required under the rules. I took a gun to my room and made a small duplicate of the target, the exact corresponding size, and hung it up on the wall across the room and got someone to help me with a stop watch, calling "commence firing" and "cease firing." I practiced consistently at this about 15 minutes a day for a period of two weeks and then went into the qualification course and fired my two strings of ten shots in 5 1/5 seconds apiece with no difficulty at all, whereas I could not very well do it in 10 seconds before.

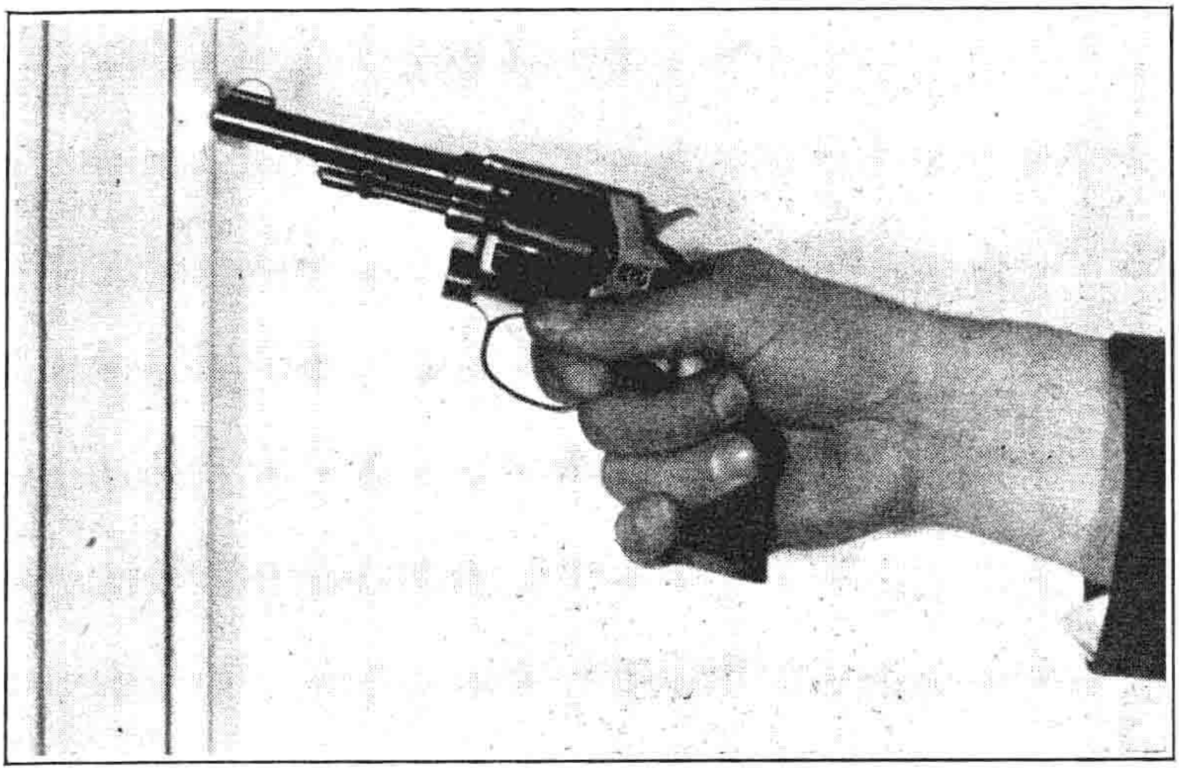


Testing the grip to see if it is firm enough to prevent the gun from slipping when executing rapid fire. This is done by taking the grip that will be used, cocking the revolver, and placing the muzzle against a firm wooden upright, as for example, a door frame, as shown. Then pull the trigger as in firing, and at the same time push forward sharply, so that the pressure of the gun against the door frame tends to displace the grip, the same as the recoil would in actual firing. If the gun does not slip in the hand, the grip is satisfactory. Note the position of the author's middle finger in this photo. It shows a good way to grip a gun with a small handle.

This shows how speed can be acquired; but though I got a good score in that practice and got the qualification of revolver expert, it was not as well done as it might have been, as I made the mistake of getting up too much speed.

In competitions the shooter should take advantage of all time allowed and not shoot his score off in half the time, losing all the rest, because the grouping is bound to be somewhat poorer than it would be if advantage is taken of every second.

There is one thing that the shooter will notice, and that is that shooting five actual shots in 15 seconds is different from merely aiming and snapping the revolver five times in 15 seconds. This is because the recoil is quite an important factor in rapid fire. It slows you up a lot and, moreover, unless you have a good method of holding your revolver, it will cause the gun to slip in your hand, so that your grip is not the same for the last shots as it is for the first ones of a string.

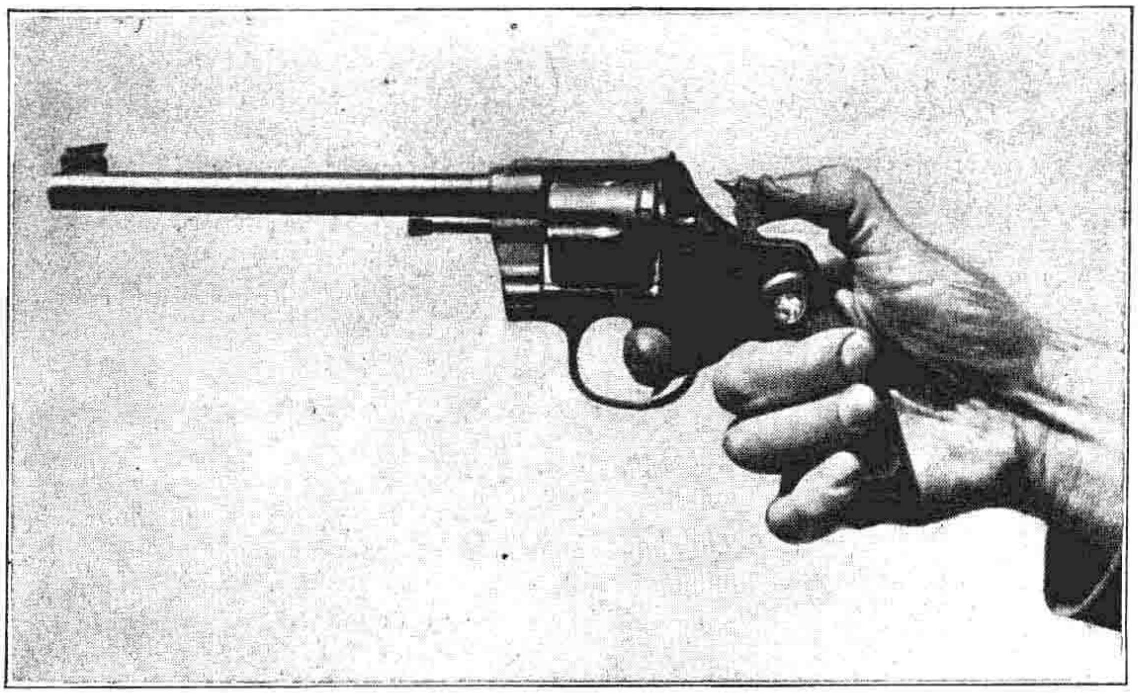


Testing the grip on the gun to see if it is firm enough to prevent the gun from slipping in the hand when executing rapid fire. This is done by pressing against a door frame or other upright piece of wood to simulate the reaction of the recoil. If the gun does not slip, the grip is satisfactory. In this case the grip did slip. Compare with previous picture showing a better grip being tested the same way.

It is particularly important for a gun that is to be used for rapid fire, either for practical shooting or for competitions, to have the grip so arranged that you are bound to get hold of it the same each time and so that your hand will not slip to a new position when the shock of recoil comes. Building out the grip behind the trigger guard with a little piece of rubber or wood and some tire tape is a wonderful help in preventing this changing of the hold.

Of course, what I have said in regard to both the grip and the cocking of the gun for each shot does not apply in the case of automatic pistols. These guns do their own cocking, and the grip is such that it does not change in your hand the way that of a revolver does. It is naturally much easier to execute rapid fire with an automatic than it is with a revolver. However, with the Army automatic the recoil is a factor that must have serious consideration, for it will throw the arm 20 or 30 degrees off the line of fire if the gun is loosely held, and this, of course, will necessitate the use of valuable time to bring the gun back in line with the target. The most successful military rapid-fire shots straighten the arm out fully and hold the gun very hard against recoil, so that it does not move much from the line of fire.

In order to prevent the grip from changing in rapid fire, it is necessary to hold the gun much more firmly in this class of shooting than in slow fire.



One method of holding and cocking a revolver for rapid fire. Note that the little finger is hooked under the bottom of the butt to keep the hand from changing position during the firing of the string. This method of holding is best adapted for small revolvers, and cannot be used on very large guns, or on those which have a butt which is thick and has sharp edges at the bottom.

In the U. S. R. A. Matches the time allowed for rapid-fire strings is 15 seconds.

At the beginning of the string the gun is loaded with five cartridges. The competitor stands at the firing-point with the arm loaded, not cocked, and the barrel pointing in a direction not less than 45 degrees from the target and notifies the scorer when he is ready to begin his string. The scorer, stop watch in hand, gives the command "Fire," after which the competitor may cock and aim his weapon and shoot his string. At the expiration of the time limit the scorer announces "Time," and no shot may be fired after this announcement. If any shot is fired after time is called, the shot of highest value will be deducted from the score.

What Constitutes Good Shooting

In the course of an extensive correspondence on shooting, the author has received many letters asking what scores a pistol or revolver shot must make to be considered a good marksman.

A very good indication can be obtained from the scores made at Camp Perry each year. In the N.R.A. matches held at that place, the high score in each match receives a gold medal and the next a silver medal and the next eight bronze medals so that the first ten scores are considered as medal scores.

In the last National Matches, which were held in 1931, the medal scores in the single entry matches averaged as follows:

Slow Fire .22 Caliber Pistol Match:
(20 shots at 50 yds., 1 min. per shot)

Winner: C. E. Ward, Los Angeles Police:	187
No. 10: Major J. S. Hatcher:	182
Average Medal Score:	184.9 or 92.4%

Slow Fire Revolver or Automatic Pistol Match:
(20 shots at 50 yds., 1 min. per shot)

Winner: J. J. Engbrecht, Los Angeles Police:	184
No. 10: Clyde J. Sayers, Detroit Police:	177
Average Medal Score:	180.5 or 90.2%

Timed Fire Pistol or Revolver Match:
(4 scores of 5 shots each in 20 seconds per score—Standard American 50 Yd. Target at 25 yards)

Winner: J. J. Engbrecht, Los Angeles Police:	192
No. 10: 1st Lieut. Clyde A. Burchan, U. S. Cavalry:	184
Average Medal Score:	186.9 or 93.4%

Rapid Fire Pistol or Revolver Match:
(4 scores of 5 shots each, in 10 seconds per score—Standard American 50 Yd. Target at 25 yards)

Winner: Sgt. J. B. Jensen, U. S. Cavalry:	188
No. 10: R. J. Nowka, Los Angeles Police:	174
Average Medal Score:	178.5 or 89.2%

In the National Individual Pistol Match of 1931 there were 637 entries. The first 12 received gold medals; the next 24, silver medals; and the next 36, bronze medals. This match is fired with the Government model .45 Automatic Pistol in three stages; 50 yards slow fire, 10 shots at the Standard American target; 25 yards timed fire, two strings of 5 shots in 20 seconds each; 25 yards rapid fire, two strings of 5 shots in 10 seconds each. The target used at 25 yards is the 50 yard Standard American with only the nine and ten rings black.

The average scores received were as follows:

	Slow fire	*Timed fire*	*Rapid fire*
The 12 gold medallists	79.7	92.7	89.8
The 24 silver medallists	81.8	89.4	84.1
The 36 bronze medallists	77.0	87.1	81.2
Average of all 72 medallists	78.9	88.8	83.3

The following results of the U.S.R.A. National Championship for 1931 are of interest, as they show not only the scores made by medalists (the first five high men in each classification), but also the type of gun and the make of ammunition used.

Match A—Revolver—50 Shots at 50 Yards
Standard American Target, Slow Fire

Place	*Name*	*Arm Used*	*Ammunition*	*Score*	*Percentage*
Champion	R. G. Pickrell	S&W .38/44	Dominion	470	94.8
2nd	R. C. Bracken	Colt Off. Model 38	U. S. Ctg.	464	92.8
3rd	W. F. Riedell	S&W .38 Spl.	Remington	455	91.0
4th	S. J. Jorgensen	Colt Off. Model 38	Peters	453	90.6
5th	M. H. Barnes	Colt Off. Model 22	Western	453	90.6
Average				459	91.8

Match B—Pistol—50 Shots at 50 Yards
Standard American Target, Slow Fire

Place	*Name*	*Arm Used*	*Ammunition*	*Score*	*Percentage*
Champion	E. S. Carpenter	S&W Olympic	Kleanbore	471	94.2
2nd	R. C. Bracken	Har. & Rich.	Peters	468	93.6
3rd	Dr. I. R. Calkins	Har. & Rich.	Western	467	93.4
4th	Cpl. J. E. Young	S&W Olympic	Western	464	92.8
5th	Milford Baker	H&R 7-inch	Remington	462	92.4
Average				466.4	93.3

Match G—Novice—25 Shots at 50 Yards
Standard American Target, Slow Fire

Place	*Name*	*Arm Used*	*Ammunition*	*Score*	*Percentage*
Champion	C. P. Gustin	S&W Olympic	Winchester	232	92.8
2nd	R. J. Dunbar	Har. & Rich.	Kleanbore	232	92.8
3rd	R. S. Furst	Har. & Rich.	Peters	232	92.8
4th	L. K. Roberts	S&W St. Line	Kleanbore	232	92.8
5th	W. C. Schwab	S&W Olympic	U. S. Ctg.	227	90.8
Average				231	92.4

Match I—Free Pistol—60 Shots at 50 Meters
International Target, Slow Fire

Place	*Name*	*Arm Used*	*Ammunition*	*Score*	*Percentage*
Champion	Dr. I. R. Calkins	Har. & Rich.	Western	515	85.8
2nd	L. K. Roberts	S&W St. Line	Western	502	83.6
3rd	Paul Pale	S&W Olympic	Peters	500	83.3
4th	G. M. Upshaw	Tell	Winchester	498	83.0
5th	F. L. From	S&W Olympic	Peters	497	82.8
Average				502.4	83.7

CHAPTER 14

PRACTICAL SHOOTING

THE real purpose of target shooting with any kind of weapon is to build up an ability to use the weapon correctly and to hit actual objects when we shoot at them. Shooting at a white paper with a black bull's-eye in the middle teaches the proper method of holding, of aiming, of squeezing the trigger, etc., and also shows the shooter where his shots go and just what accuracy can be expected.

Unless we are going to follow target shooting as a sport, to the exclusion of all other kinds of shooting, the next thing to do after we have learned to shoot so that we can hit the target every time, and have acquired a fair degree of accuracy and confidence, is to learn to use our pistol or revolver for what is known as "Practical Shooting" as distinguished from target work. Practical shooting is using the weapon as we would on a hunting or camping trip, or as we would in a wild country where the object of owning a gun is utility and not target practice.

In several ways, practical shooting differs very greatly from slow fire target practice, but learning to shoot accurately at a target is the foundation of good shooting of any kind. Many practical users of pistols or revolvers are fond of making fun of target shooting, and of the advice given on how to learn this branch of the sport. Such an attitude is well understood by the psychologist. It is founded in the unconscious jealousy and feeling of inferiority that the poor shot feels when he sees a well trained marksman making scores out of his power to equal. Unconsciously he will try to belittle that accomplishment that he does not possess, so that he will seem to his audience to be just as important and well equipped as the good marksman whom he ridicules.

It is very true that practical shooting differs very greatly from target shooting in several important particulars, and that a target shot who has never had any experience or training except slow fire at a bull's-eye is apt to give an ordinary account of himself in a gun-fight; but just the same, instruction and practice in accurate target shooting is the foundation of all success in practical shooting as well as in target work.

As a matter of fact, what instruction and practice in slow-fire target-shooting and then in rapid-fire target-shooting does is to drill thoroughly into the marksman's physical make-up an ability to contract the muscles of the hand easily and smoothly, so as to let off a shot without twitching the pistol in one direction or another. The trigger squeeze is only the first foundation of this later acquired smoothness of muscular contraction. Anyone who makes good scores with a pistol or revolver, whether at target-shooting or at practical shooting, does learn in time to do exactly this, and the quickest way to learn it is in the manner outlined in the preceding chapter.

The practical shot who has learned to shoot without any target practice is likely to possess only a very sketchy degree of accuracy. Most likely he will be what is sometimes described as a "trigger snatcher," able to register a large percentage of hits on a man-sized target at ten feet, but likely to make as many misses on the same target at twice the distance.

On the other hand, the target shooter who has graduated to the "practical" stage is likely to be a first-class marksman at either slow or rapid fire target shooting, or at standing or moving objects of any kind. I know several excellent target shots who can toss a half a brick into the air and hit it once, or even twice with a revolver before it hits the ground. Moreover, these men, even the best and fastest of them, use the sights for such shots.

Again, the "practical shot" who has no knowledge or experience of accurate target shooting with a revolver may find himself at the mercy of a good target shot, regardless of what that target shot knows or does not know about practical shooting. Thus some years ago on the Mexican border a tough two-gun man who had successfully defied the local authorities was arrested by an army captain, an acquaintance of the writer, who had acquired a reputation in that vicinity for long range marksmanship with a revolver. This capture was accomplished with amazing simplicity and ease. The "bad man" was utterly reckless, and was a quick and deadly shot with his revolvers at ranges under ten yards, but was unable to score a hit on a man with certainty at ranges beyond that distance. Fifty yards away the officer drew his revolver and ordered the other to halt, take out his guns, drop them on the ground, and walk away from them. The "tough hombre" meekly did exactly as he was ordered, for he knew that the officer could hit him at 50 yards or at 75. He knew that if he started to run, he would be a dead man, so that there was nothing for him to do but drop the guns as ordered, for even though he had two of them, he was fully aware that he could not shoot accurately enough to come anywhere near hitting the officer that far away.

There are several ways in which practical shooting differs from bull's-eye shooting. One is the difference in aiming, and in the way the sights show up. Another is the fact that practical shooting frequently requires the exercise of great speed. This speed may be necessary for hitting an object quickly when the gun is already in the hand, or, what is even more difficult, it may involve getting the gun quickly into action from the holster or pocket, and then hitting the object. Again, in practical shooting, situations frequently arise where the sights cannot be seen, and the shooting must be done by using the sense of direction only, as in pointing the finger at an object.

As for the question of sighting, the user of any gun will quickly find that aiming at an object in the woods or on the ground is very different from aiming at a black bull's-eye on a white paper, where the sights are clearly outlined against the white background. The sights that are best adapted to shooting at targets are the hardest to see and the poorest for use in the woods. On the target range, the sights are seen against the white paper, and they should be black, without any bright or shiny spots on them. In the woods, such sights often cannot be seen at all, and if they are seen, it cannot be told whether or not the front sight is in the middle of the rear sight notch. Therefore, for use in the woods, the sights should have the visibility increased in some way, which is usually accomplished by the use of a gold or ivory bead on the front sight. Sometimes also, the rear sight notch is outlined with white lines inlaid in the metal by making a groove around the notch and filling it with white enamel. Some of the King rear sights are made this way, and are excellent when used in connection with the King Ramp—Red Bead—Reflector sight, which has a red bead front sight with a chromium mirror let into the ramp under it, to reflect the light of the sky onto the bead.

In target shooting, it is common to use a wide rectangular front sight, with which aim is taken just under the bull's-eye. This works beautifully when the bull's-eye is always of the same size, and outlined clearly in black against the white paper; but it does not work so well when the aim may be at any one of a large variety of different objects with different colors, sizes, shapes, and backgrounds; and when the object may be moving or a wind may be blowing. In such a case, what is wanted is a small bead front sight, used with a U rear notch. Aim is taken directly at the point which it is desired to hit, with the bead held high for longer ranges, to compensate for the drop of the bullet. If the object is moving, the aim is shifted slightly to the direction of motion; or if the wind is blowing, the aim is shifted against the wind. In all these cases, it is better to have the gun sighted so that the bullet will hit when the sighting is right on the object at medium ranges. Then at longer or shorter ranges, the bead can be elevated or lowered in the notch, an amount for each range that will quickly be learned by experience. Sighting right on is better than sighting under when an allowance for motion or windage may have to be made by holding off. It is hard to hold off a certain amount when holding under at the same time.

As for the matter of speed, it is quite natural that in shooting at small game, etc., there would be more need for quickness in drawing the gun and in getting off the shot than there is in the case of a target, which will not move off at once, but will stay in position indefinitely. The question of speed shooting will be taken up in detail presently.

How To Learn Practical Shooting

After a satisfactory degree of proficiency in accurate shooting has been learned by target practice, and the shooter has confidence in the accuracy of his weapon, and in his own ability to use it so to place his shot close to the place desired, he is ready to learn practical shooting.

For this purpose a .22 caliber gun is best. The recoil and noise are so slight that there is little or no tendency for them to hide the errors of holding that may occur, as is the case with the .38 or the .45. Moreover, there is little tendency to flinch where the disturbance that accompanies the pulling of the trigger is reduced to a minimum. But perhaps the greatest advantage of all is the reasonable cost of the ammunition. With the inexpensive .22 caliber cartridge, an almost unlimited amount of shooting can be done at very little expense, whereas there are very few marksmen who can afford to blaze away at random with the .38 or .45 caliber cartridges at a cost of several cents a shot. And after all, practice is what counts.

In the woods, on the mountains, on the beach, or around the fields of the farm there are always hundreds of objects which make safe and interesting targets. Among the best targets are tin cans, bottles, floating objects, etc.; in short, anything that gives a visible reaction to a hit.

If the man who desires to become a proficient practical pistol shot will simply carry a .22 caliber revolver or pistol with him on his trips into the outdoors, and will take advantage of the opportunities that occur to shoot at safe and interesting targets as they present themselves, he will not only have a tremendous amount of exhilarating sport, but he will also rapidly become a good practical marksman.

Shooting on the water is excellent, for the splash of the bullets tells where the shot has gone, and the misses as well as the hits thus become instructive and interesting. It is practical to stand on a beach or a pier, and shoot at different objects in the water or on the beach which are at various distances from the gun. This teaches the estimation of ranges as well as the art of shooting. Moreover, it teaches how much the shooter must hold over for the longer ranges. Objects from ten to two hundred yards away may be used.

The publisher of this book, T. G. Samworth, is a formidable pistol shot. Recently I visited him in North Carolina, and together we stood on the end of a private pier and practiced shooting as above described. The location was far enough from any other habitation so that there was no danger in firing a .22 in any direction; and the irregular shore line, with objects jutting into the water at various distances, together with stakes driven into the water to mark sand bars, etc., gave us an abundance of targets. In addition, there were several floating objects in sight.

Together we stood on the end of the pier and fired in turn, emptying our .22 caliber revolvers at the various likely targets. The rule was that the shooter could choose any object he desired, but it must always be at a considerable angle from the last target, and at a different distance. This makes a sort of competition of it. Shooting this way, at objects up to 150 yards away, there will be many misses; but the relative ability of the rival marksmen in placing their shots will soon be apparent.

On a high bluff overlooking a wide body of water, with the wind blowing away from shore, there is opportunity for friendly rivalry and good practice. Tin cans, bottles, or old burnt out light bulbs make good targets. One such object is thrown into the water, and as it floats on the surface and is carried out from the shore by the wind, the marksmen fire at it in turn. Quite often, even with good marksmen, there is danger of having such an object get clear away; for as it is blown away from the shore by the wind, each shot is at a greater range, and is therefore harder than the last. It is very useful to have a .22 rifle near by to use when the target gets beyond pistol range.

Another splendid and most practical method of accumulating a combination of both speed and accuracy in hand-gun shooting is a procedure I have seen and tried, aptly called by its originator "Battle Practice." All that one needs for this game is a safe place to shoot and a supply of readily improvized targets. Small empty tin cans make the best marks, but blocks of wood will do also. Bottles are also interesting, but have the double disadvantage of being available for use but once and of littering the place with broken glass.

First, erect some sort of a rail or plank on two supports, so that it forms a shelf about twelve feet long and about four feet above the ground. Then place on it a row of the tin cans at intervals of a foot or so apart; if you are using revolvers six cans will be enough but if automatics are in use even ten or eleven targets may be used; with a pair of skilled shots a target for each cartridge in the gun will prove none to many in the end. The targets must be arranged so they will readily fall from the shelf when hit.

The procedure is for two shooters to engage, one against the other with both contestants standing side by side and about 15 yards from the targets. When the word is given each shooter commences firing at will, both firing at the same can, the one on the left. As soon as it is hit, it will fall off, and then both contestants shift to the can next in line. Under no circumstances must either contestant "jump ahead" a can or so, which a slow shot may be tempted to do when he finds he is outclassed. The object is for one shot to knock down each and every can in the line before his opponent can hit it. As soon as one can is down, each shooter turns his attention to the next one and no shooting shall be done at any others until the can on the left of the line is down. This practice is a splendid way to teach speed of fire with accuracy. In effect both shots are firing against but not directly at each other and it is a most practical method to learn to shoot rapidly. At times, particularly with a pair of equally matched shots, it will be difficult to keep an accurate score, but the object of the game is more instructive than competitive and it is one of the most appealing and interesting forms of practical shooting which has come to my attention.

This game will improve the combined speed and accuracy of your pistol shooting more quickly than anything else that I know of. As one's skill improves it is merely necessary to step back a few yards further from the targets. Also, it is possible to use this same general scheme of shooting with other forms of practice; for instance a couple of "quick-draw" enthusiasts can start off with their guns in the holsters and draw and fire shot for shot at the marks. In case this is tried I would advise extreme caution at first and until great skill has been attained by both contestants, as one shooter might accidentally wound the other through having his gun go off in the act of being drawn.

Speed Work

The type of shooting described above will noticeably increase the speed with which the pistol or revolver is handled. Further increases in speed will result from shooting rapidly at moving objects, such as a block of wood floating downstream in a swift current, or a swinging target made by suspending a weight by a piece of string.

A type of shooting requiring speed and a knack of knowing just how to aim and when to pull the trigger is the shooting at objects thrown into the air. This is made harder when the object is thrown with the gun hand, and the gun is then removed from the holster and used to hit the object. If two or more objects are thrown at the same time, even greater speed is required.

Again, speed work is sometimes done at plain targets, the object being to see how quickly the gun can be drawn and the six shots be delivered onto a given area of the target.

When a really excellent super speed shot reaches for the gun in the holster, his first finger goes into the trigger guard, his thumb on the hammer, and the other three fingers surround the grip. As the gun comes away from the holster, he cocks it, and extends it in the quickest direction toward the object to be shot at, and as the gun lines up, he contracts the hand all over, which causes the trigger to be pulled without jerking the gun one way or the other or disturbing the aim.

Much practice in this with the pistol unloaded is of great value in acquiring speed of draw and let-off, but a loaded gun will always be found to be slower than an empty one. This is due to the psychological effect of the greater care necessary with the loaded gun.

To give an idea of just what speed can be accomplished after long and arduous practice, the following figures are given. These are from the experience of Mr. Ed. McGivern, of Lewistown, Montana, who is undoubtedly one of the fastest pistol shots in the world.

To draw from the holster and fire one shot, making a sure hit on a man target at 10 yards, 1/4 to 3/5 second.

To draw from the holster and fire five shots with sure hits from double action revolver, 1 1/4 seconds.

Same with the single action gun, with slip hammer, using two hands, 1-3/5 to 1-4/5 seconds.

Same with single action gun, "fanning" the hammer, using two hands, from 1-3/5 to 2 seconds.

Good groups of five shots with double action revolver without the draw, using one hand, 3/5 to 9/10 second.

Good six shot groups, double action, using one hand, 4/5 to 1 second, giving groups not larger than a man's hand.

Shooting 5 targets, (clay pigeons) tossed into the air by two throwers at approximately the same time, using double action revolver, 1-4/5 to 2-4/5 seconds.

Shooting a tin can tossed into the air, 5 shots and 5 hits, with double action revolver, 1-3/5 seconds.

Throwing a target into the air with right hand, then drawing the gun with the same hand and breaking target, from 3/5 second to 1 second.

Mr. McGivern finds that getting off the first shot averages about the same time from either a single action or a double action revolver; but that the remaining shots cannot be delivered nearly as fast with the single action. Moreover, the double action guns are much more durable and reliable. Therefore he uses the double action guns, *and shoots them double action* in his stunts. Moreover, he uses the sights. His guns are all fitted with gold bead front sights, and he says "I'm often asked if I really do use, and really do see, the gold bead front sight when shooting aerial targets in a hurry. Yes, I certainly do! I've grown used to having them on my guns. I need them for my kind of shooting. And I use them! Just the instant one of the front sights is injured in any way, or changed at all, I notice it. Revolvers or pistols with the sights filed off or otherwise destroyed, are good for just one thing, and that is killing or maiming men at very short range, which was exactly the purpose for which they were used if and when they were used."

Instinctive Pointing

While I agree fully with the ideas of Mr. McGivern about the necessity of sights, I consider it important for the practical pistol shot to know how to get fairly good results without using the sights at all, but rather, pointing the gun entirely by instinct, as the finger is pointed in indicating an object. This is really very important, because any shooting that may be done at night will have to be this kind. Also pistol-shooting on the battle field or in holdups is more likely to be at night than at any other time.

You will find that if you will suddenly extend your arm and point your finger at any object near you, the finger is pointing pretty closely in the direction of the object in question. In the same way a pistol or revolver can be pointed without looking at the sights. One thing that makes it hard, however, is the fact that pistols and revolvers are of so many different shapes and that most of them do not point in the same direction that the finger would without considerable practice.

The Remington Model 51 automatic pistol was carefully designed after months of study, with the object of having it point just where the finger would point if it were not on the trigger. Many other pocket automatics point in the same way, and the Colt Woodsman and the Luger are among the best in this respect. The .45 Government Model Automatic also closely approaches this ideal, especially with the improved mainspring housing adopted about ten years ago.

While revolvers do not point in line with the first finger, nevertheless, if you use one type of revolver and stick to it, you can easily learn to point the barrel accurately without using the sights.

A very good way, indeed, to practice instinctive pointing is to fix the gaze on some object, and then close the eyes and point the gun at this object with the eyes closed. Open the eyes and see how near you are pointing to it.

Another way is to point into the mirror. Standing about 10 feet from a mirror, point the pistol suddenly at your own eyes and by looking at the reflection you will see whether or not it is actually aimed right. If so, you will be looking exactly into the muzzle.

In this pointing practice, it is best to draw the pistol from the pocket or a holster, extending it directly toward the target and cocking the revolver at the same time it is drawn.

After practice has taught you to line the gun up accurately on objects in this manner, the next thing is to practice snapping as you line up the gun, so as to preserve the knack, which has already been learned, of just contracting the hand without any twitch that will throw the gun off.

The next step is to test your ability by actual firing without looking at the sights. If you have a place where you can shoot into the water there is nothing better, as it shows you where your shots are going. A tin can or bottle thrown in the water and blown rapidly away from the shore by the wind makes a first-class object to practice on; but in this kind of practice be sure you are shooting in a safe direction, because bullets may glance from the water and go a considerable distance.

A number of years ago, when living in Florida, I used to carry a .22-caliber revolver in a holster at all times, and as I was in a rather wild part of the country, I could always shoot whenever I wanted to without danger of hitting anyone. The use of the .22-caliber cartridge was adopted because it was the only way to keep the expense down to a reasonable amount and still be able to use the number of cartridges it seemed necessary and desirable to use. In going through the woods anything that offered any kind of target was usually shot at, especially white mushrooms and toadstools, tin cans or bottles.

Another practice that I indulged in with this .22 was shooting at these same white objects at night. Along the beach white shells on the sand make a fine target for this kind of work, and a splash of the sand will generally show where you have hit; but it is utterly impossible to see the sights even in the moonlight.

Such practice as this, especially if you will stick to one particular gun, will rapidly train the subconscious mind so that the hand will always hold and point the gun so as to send the bullet into the right place.

It is surprising how soon you get so that you can simply extend the gun toward the object in question, at the same time smoothly contracting all the muscles that do the trigger pulling, and strike just about the mark.

We have mentioned several times, both in this chapter and elsewhere, that the best way to aim is to extend the revolver straight out at the object you are going to shoot, and not swing it from the shoulder in the old western style. This gesture had a reason in those early western days and was necessary. The reason was that the muzzle-loading or cap-and-ball revolvers were used, and when a cap was exploded it split in fragments which were liable to get into the revolver mechanism and clog the works. Swinging the gun with the muzzle vertical when cocking allowed these pieces to fall off of the nipple and drop to the ground.

Hip-Shooting

Another form of instinctive pointing embraces what is known as "Hip-shooting." This is simply the firing of the gun from the level of the hips, without ever raising it to the level of the eyes. The old .45 Colt Single Action has the barrel set at such an angle to the grip that when held with the hand on the hip the barrel naturally points straight forward. For very close range work deadly shooting could be done in this way with that weapon. It was thus best adapted for the type of shooting sometimes practiced in the old western days—that of shooting through the bottom of the holster.

Hip-shooting is spectacular and interesting; but I do not consider it to be of much practical value. Much closer pointing can be done, and the shot fired just as quickly, by extending the gun toward the target, as above mentioned. Try pointing the finger at some object, holding it at the hip, and you will find it is not as easy as holding it off. You are likely to deviate from the direction intended. But a considerable amount of proficiency can be obtained in hip-shooting if you only practice it.

Recently an especially effective method of hip-shooting has been taught to the police of San Francisco and other western cities by Capt. W. H. Sweet, U. S. Army.

In Capt. Sweet's system, the gun is worn on the left side, in either a belt or a shoulder holster. It is drawn by the right hand and grasped by the right hand in the usual manner; but instead of being extended in the usual manner, it is held close against the body at the waist, pointing directly to the left. At the same time the left hand grasps the frame of the gun, with the thumb on top, over the cylinder, and the first two fingers of the left hand on the bottom, the first finger just forward of the trigger guard, and the second finger under the guard. The left hand thus holds the gun firmly, and steadies it against the body. The gun itself does not touch the body, but both hands holding it do.

As the gun is brought into action, the body is turned so that the left side is directly toward the target, thus bringing the muzzle of the gun into that direction, and also presenting a smaller target toward the adversary. The shooter does not look at the gun at all, but looks at the target, and when things seem to be lined up about right, he pulls the trigger.

Lots of practice is what really counts in acquiring ability in hip-shooting. When the Model 1917 revolver was first adopted samples of these weapons were tested to destruction by the Government under the writer's supervision. These guns stood up for five or six thousand rounds. In one of these guns I fired nearly all of the 5,000 rounds of the test personally, shooting from the hip into a bank of sand at targets, cartons, etc., and soon learned to make a high percentage of hits.

Another thing learned in this test, which is only mentioned here as a matter of interest and not because it has any utility, is the fastest way to discharge six cartridges in a revolver. It can be done in a fraction of a second, and so fast that it will mystify people greatly if you do it without letting them see how it is done, because it almost sounds like only one explosion. It is done by taking the revolver in the left hand and placing the right forefinger on the trigger, thus using both hands. Pushing the hands together works the double action and makes the cartridge go off and at the same time the spring of the trigger will move the gun to its former position, and also push the hands apart. This motion can be repeated with great rapidity; try it with an empty gun some time.

Never try hip-shooting with the .45 Automatic. It will eject the empty cartridges straight into your face and may inflict serious injury.

Long Range Shooting

The limit of effective revolver range is usually considered to be about 75 yards; but this is not because the gun will not carry farther. It is because of the difficulties of aiming a one-hand gun, with its short sight radius, so as to hit an object at the longer ranges. The bullet from a revolver travels comparatively slowly, and therefore the trajectory is high; that is, the bullet drops considerably except at very short ranges. Revolver bullets will carry up to 1,000 yards and over with the heavy calibers, and at these ranges are capable of killing. At 50 yards the average revolver is capable of grouping its shots in a six-inch circle or less, and at 100 yards you could hit an object the size of a beer keg, provided you could hold steadily enough. At 300 yards, you can still put all of your shots, with the ordinary large caliber revolver, onto an object about the size of a barn door.

Recently, the capacity of the revolver for long range work has been considerably increased by the introduction of high velocity loads in the .38 caliber. The regular .45 Colt drops 131 inches in going 200 yards, and the .38 Special drops 108 inches; but the new .38/44 drops only 69 inches at the same range, and the sighting of the gun compensates for about 25 inches of this drop, so that by holding about four feet over the target at 200 yards with this gun we should be able to get a hit. By steadying the gun when shooting, we should be able to get a group not much over three feet wide. For all long-range shots it is advisable to rest the revolver in some way in aiming. One way is to shoot with both hands by grasping the revolver in the right hand and taking hold of the wrist with the left hand, so as to steady the arm as much as possible. Another way is to lie down flat and rest both elbows on the ground, and hold the gun with both hands. Still another way is to use any solid object for a rest, and resting the wrist or hand on the object. In using a rest to steady a revolver, never rest the barrel or frame of the gun on the object, as this will give a different kind of recoil, and therefore the grouping will not be the same as when shooting offhand. In shooting at an object over about 75 yards away, you must allow for the drop of the bullet by aiming above the object, as revolvers are always sighted for short ranges, not over 50 yards. The amount of this allowance for drop varies with the velocity of the bullet and its wind resistance. A table of drop for the various calibers at different ranges is given in Chapter 9.

CHAPTER 15

HINTS ON USING HAND ARMS FOR DEFENSE

THERE is one vital necessity in the everyday life of the average citizen that is filled by a revolver, and can hardly be filled in any other way. This is the need for an arm of defense. This is the real reason for the existence of the revolver or pistol today.

Some of the circumstances under which it may be vital to have one of these arms on hand are in the case of families living in detached houses in the country, where the women folk are likely to be left alone when the men are away on business or in the fields. What man would want to go away and leave his family with no means of protection against the ordinary tramp or marauder who otherwise could work his will unmolested?

Efforts to Disarm the Citizen and Their Effect

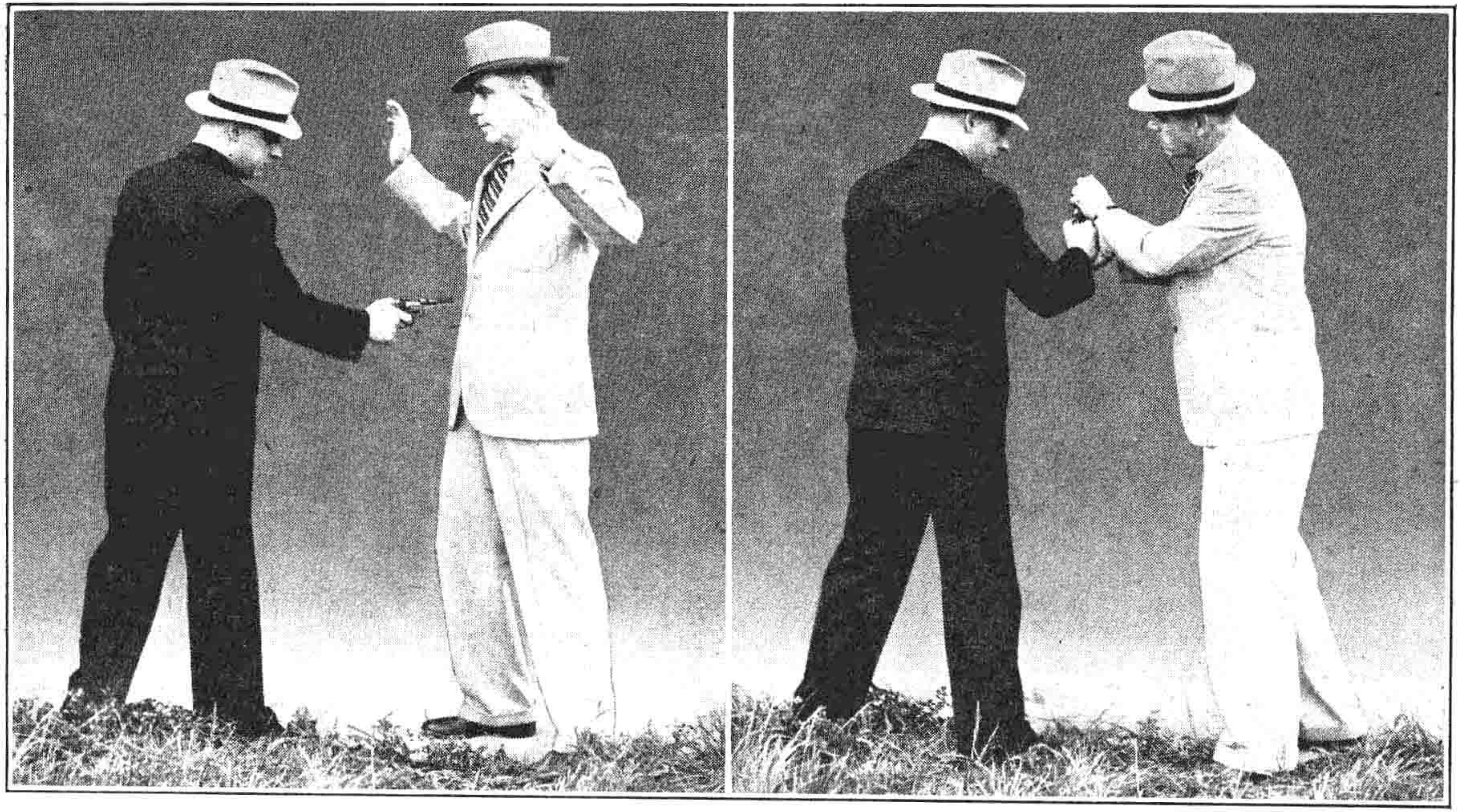
There are a number of individuals who at the present time are devoting a world of energy to an attempt to regulate the pistol or revolver out of existence by means of drastic laws forbidding the sale or possession of such weapons. They argue that the regularly organized police departments are sufficient protection, and that anyway, the citizen, if held up, should not resist, as some one might get hurt. The efforts of these misguided and pusillanimous individuals have resulted in making holdup, robbery, attacks on couples in parked cars, etc., safe and easy. The criminal knows that he has little reason to expect resistance from his victims in cities and states where there are drastic firearms laws. Such states and cities have accordingly become the happy hunting grounds for criminals of all kinds.

The theory that the police will always be available for protection in such cases is so ridiculous as scarcely to deserve notice. Even in a city, there are hundreds of times and places where no policeman is on hand; and in rural districts, the holdup man's chance of encountering the forces of the law are nil. In such cases the possession of a revolver and the knowledge of how to use it are the only safeguards of the law-abiding citizen.

For example, I knew of a case in the outskirts of a small southern town where everybody was away from home except a young woman about 18 years of age. She happened to glance out of the window and saw two colored men stealing peaches off of the trees in her garden. She went out and told them to go away, but they merely laughed at her and continued to pick peaches. It just happened that this young woman was a crack shot with a revolver. She disappeared into the house and a moment later she stepped out of the door armed with a .38 Smith & Wesson Military and dropped a shot through the bucket that one of the colored men was carrying. The pair dropped the buckets and stood not upon the order of their going. It was rumored that a couple of colored men in that vicinity were several shades lighter in complexion than they were before.

The Smith & Wesson .32 Hand Ejector. This excellent little revolver, chambered for the .32 S. & W. Long cartridge is a duplicate in design of the large Military Models. The round butt is a most desirable feature, as it makes the revolver less bulky to carry, and moreover, is a more comfortable handle to use. The .32 H. E. is especially desirable as a self-defense gun for use by women.

Another and more common incident will be quoted. On the outskirts of a city a woman of my acquaintance called up the police department late one night and complained that a man was trying to get into the house and asked for assistance at once.

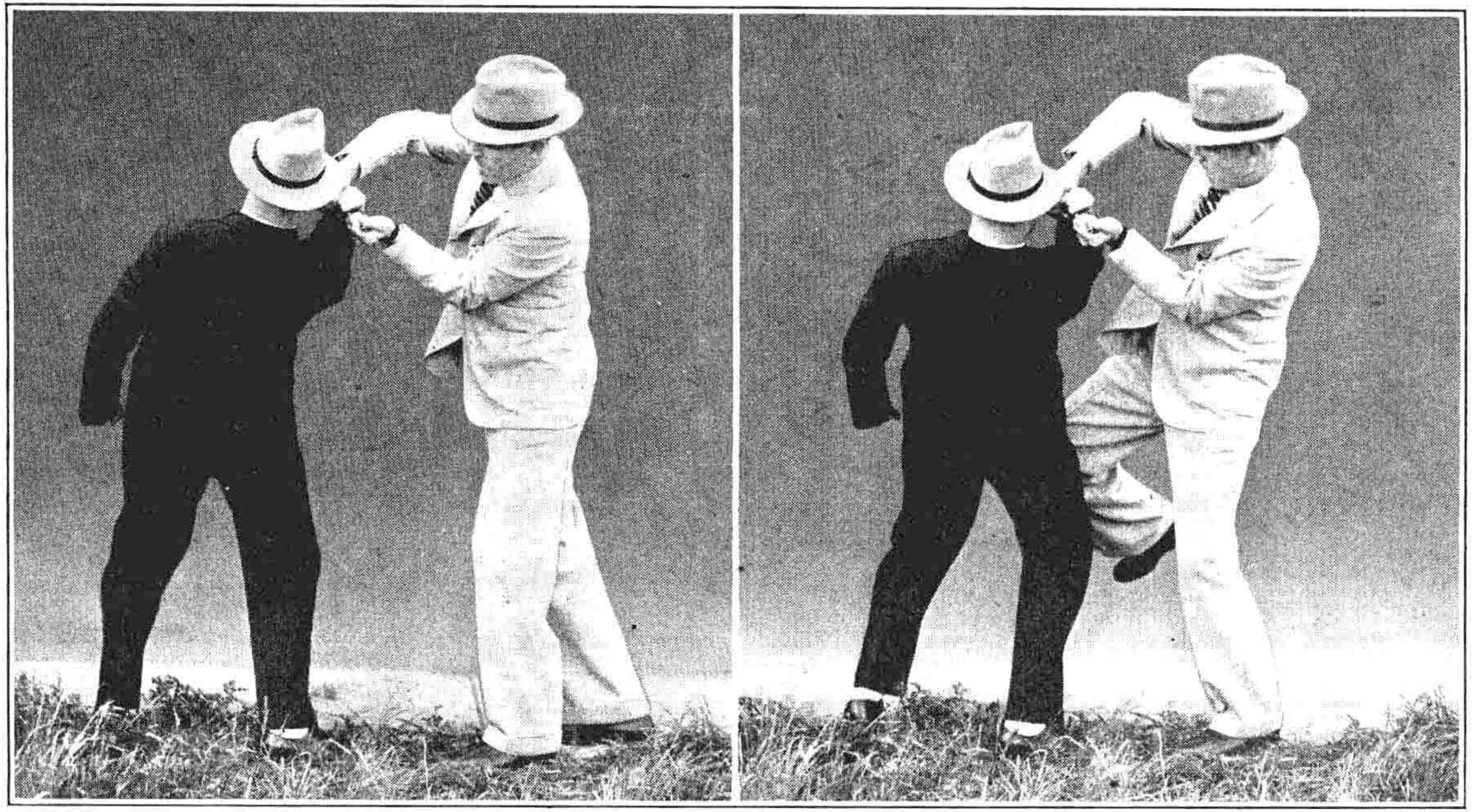


FOILING AN ATTEMPTED HOLDUP. SERIES A. BANDIT IN FRONT OF INTENDED VICTIM, WITH GUN POINTING SLIGHTLY TO THE RIGHT OF CENTER OF THE VICTIM'S BODY.

Left: Position 1. The bandit points the revolver at the intended victim, who notes that it is pointing slightly to the right of the center of his body, and starts to raise his hands as commanded.

Right: The intended victim, noting that the muzzle of the gun is pointed slightly to the right of the centerline of the body, drops his left hand quickly onto the gun, pushing it to the right before it can be discharged. At the same time he turns the body slightly to the left, so that if the bandit succeeds in discharging the gun the bullet will pass to the right of his body. As he drops his hand on the gun and pushes it to one side, he grasps the barrel, and then places the other hand under the butt as shown.

These and the other pictures in this series were posed by Lieut. H. Laurence Gau, Ordnance Reserve, and the author. Lieut. Gau, seen holding the gun, is Pistol Instructor of the Maryland State Police.



SERIES A. NO. 3. FOILING AN ATTEMPTED HOLDUP, POSITIONS NO. 3 AND 4.

Left: With the right hand under the butt of the gun, as shown in position No. 2, hold the bandit's hand firmly onto the butt of tl pistol, and swing the muzzle vigorously upward and to the left. This will put a painful strain on the bandit's wrist and throw him on the back of his head, and will leave the gun in the possession of the intended victim.

Right: As the bandit is being thrown, as described in No. 3, he may be further disabled by striking him with the knee as shown, if opportunity offers.

She was informed that they were sorry but her house was outside the city limits and they could not send a policeman there as it would be off his beat. Fortunately, she had a pistol and was able to frighten the intruder away.

What would either one of these women have done without a revolver in the house? Yet there are people who are today agitating the passing of laws to prevent anyone from having a pistol or revolver for any purpose.

Another place where it is desirable to have a means of defense is in an automobile. I knew a man whose car ran out of gasoline on a wild and lonely road several miles outside of a large city on a bitter cold night. He had to leave the car there and walk about a mile for gasoline, and his wife, who was in the car with him, had the alternative of either sitting in the car by herself or walking with him in the snow and bitter cold. This man happened to have a .45 Automatic with him, which he placed in his wife's hand and said, "If anyone bothers you, shoot first and ask questions afterwards." Yet the anti-firearms agitators would have left that woman perfectly defenseless on a wild and lonely road.

A revolver or pistol is a necessity for storekeepers, paymasters, bankers, jewelers, etc.

The agitators who have been working on this anti-firearm legislation have succeeded in having drastic laws passed in several States forbidding the possession of hand firearms of any kind, except by officers of the law or members of military organizations. Any one of these States is a Mecca for crooks and thugs of all kinds, because the law practically assures them that they will be able to ply their trade of holdups without the slightest danger of being shot. The crook, of course, cares nothing for laws against having firearms, and he knows that the law-abiding citizen will obey the law; therefore he is safe.

A man starting out on a career as a holdup artist always examines carefully the laws of all different States and goes to the one where his trade will be the safest, and that is the State which has the anti-firearms laws, which will assure the thug that he will find his victim unarmed, and therefore he will be in no danger of being either resisted or shot.

One of the most drastic anti-firearms laws is on the statute books of Illinois, and we have all heard of the Herrin murders, which recur with startling regularity, and of the activity of the famous Chicago bandit gangs. These revolver laws, of course, simply play into the hands of the thugs and the lawless element.

One of the most notorious of these laws is the Sullivan law of New York State. This law forbids the owning of a revolver or pistol without a permit. Of course, it can not bother the crook who has only to go on a short trip out of the State and get his gun whenever he wants it. Revolvers are cheap, and he will not be caught with it on him after a crime. The professional murderer, who is out to "bump off" a selected victim, ties his revolver onto the end of a string, steps up to his victim and shoots him, gives the revolver a couple of whirls on the end of the string and lets go. The revolver flies over the nearest row of houses and lands in some back lot, like a stone thrown from a sling. The crook sticks his hands in his pockets and goes merrily on his way. If arrested he is deeply surprised and hurt, and of course no evidence is found on him.

The following examples will show some of the practical effects of this law: An acquaintance from New York related that a small storekeeper in Brooklyn was robbed several times in succession; so finally he decided to sit up all night and wait for the robber. He got a pistol and sat in his store waiting. In the small hours of the night he made the rounds to his front door, and a police officer on the beat, who was a friend, saw him inside and knocked on the door. He let the officer in and passed a few words with him, mentioning the fact that he was trying to catch the man who had been robbing his store. The officer asked how he was going to catch him if he came, and the storekeeper replied that he had a gun. The officer at once placed him under arrest and rushed him off to the station house for violation of the Sullivan law.

It is said that a widow looking through her husband's effects after his death found an old revolver. She knew about the Sullivan law and did not want to be a lawbreaker, so she telephoned the police and told them about it and asked them if they would come and get it. She was arrested for having a gun in her possession.

The following Associated Press dispatch from New York, under date of September 28, 1926, speaks for itself:

"Aurelio Valdes, a painter, examined some second-hand furniture which he had bought for his home and discovered a revolver in a table drawer. Being a law-abiding man, he took the weapon to police headquarters, where he explained the circumstances and said he wanted to turn in the pistol. The police promptly placed him under arrest for violation of the Sullivan law, and on that charge Valdes was arraigned in night court. Again the circumstances were explained, and Detective Schmuckler corroborated Valdes' account of his visit to headquarters. Magistrate Glatzmayer said he had no recourse but to hold Valdes for trial in Special Sessions, but that he would fix bail at the lowest possible amount—$25. Mrs. Valdes said that even that sum could not be obtained. They had a child, she said, and she had to work, as well as her husband, to keep the family together. Bail was given finally by Magistrate Glatzmayer himself."

In spite of the drastic manner in which law-abiding citizens are disarmed in New York State, no one who has his feet on the ground and knows what the conditions around a large city are would expect the crook to be disarmed, but he would be rather surprised to know that prisoners in Tombs Prison, under the direct personal care of all the guards, would be able to have firearms, yet, about 3 p.m. on November 3, 1926, three desperate criminals in this prison, while being taken to the infirmary on their pleas of illness, drew automatic pistols and shot their way to the prison yard and killed the warden and one keeper before being finally cornered. They were finally subdued after a battle lasting nearly an hour, in which more than 200 policemen were engaged, who used machine guns, rifles, pistols and gas bombs from the wall of the prison and windows of skyscrapers. If an anti-firearms law will not disarm the prisoner in a cell, who has been searched before he was placed there, how can it be expected to disarm the thug who roams at large?

We have mentioned some of the abuses that the anti-firearms law has led to in New York State. In some other States it has been said to have led to even greater abuses. It has led to the corruption of officials and the institution of wholesale graft, according to capable writers who investigated conditions in these places.

For example, one such law forbade the possession of hand firearms except on the issuance of a license, revokable at will, and issued by a justice of the peace on the payment of a fee, which went to the justice himself. There are justices and justices. Most of them are, of course, absolutely straight, but money talks, and it was found that under this system many dangerous crooks who were arrested had perfectly valid licenses for having guns in their possession. It is said that conditions became so bad that the law was revised, doing away with the licenses, and forbidding all hand firearms except in the hands of members of military organizations, police officials and certain deputies.

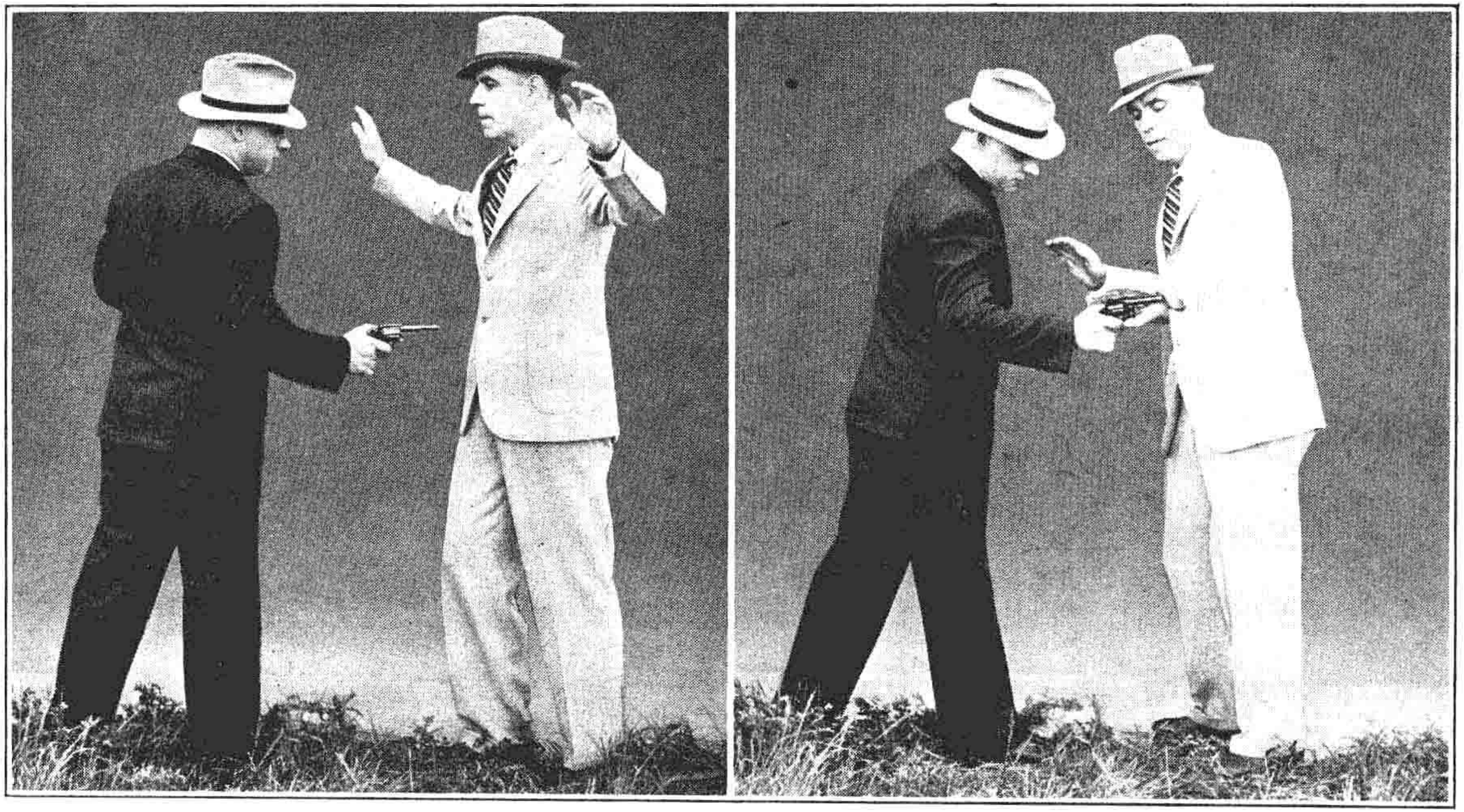
Of course, it is an extremely easy matter for any enterprising crook to get a revolver or pistol when there are antirevolver laws in one State and the next one allows free traffic in these articles. The advocates of laws restricting the sale of revolvers and pistols suppose that by making a uniform law for all States, prohibiting the manufacture or sale of hand firearms, it will stop anyone from obtaining them. This is not a well-founded supposition at all, because it is a very easy matter in a few minutes to cut off a rifle to a pistol-barrel length and whittle off the stock in such a manner as to make a pistol out of it. The smuggling of firearms and the bootlegging of pistols would grow to be a very profitable business, and there would be plenty of them to be had if only the price were forthcoming.

Even if anti-firearms laws were enacted which succeeded in suppressing all firearms, there would still be plenty of easy ways to commit suicide or murder. When a criminal is bent on committing a homicide he merely chooses the easiest way to do it. If that method is not at hand, he chooses another method.

At the present time most suicides are by means of illuminating gas, and if no pistols were to be had, it would still be possible for everyone to get hold of knives, hatchets, or other deadly weapons, and these have the advantage over the pistol or revolver for the perpetration of a crime, in that they do not make any noise and thus raise an alarm. If all pistols and revolvers were suppressed, murders and suicides would not decrease, but there would be a large increase in the number of knife murders and "cuttings."

Already it is noticeable that the common ten-cent store ice-pick is becoming popular as a stiletto. Its cost is practically nothing, it can be purchased or carried by anyone with no danger of legal difficulties and without interference from anti-firearms laws; it deals death silently and swiftly, and moreover it cannot be identified by rifling marks, etc., and its ownership proved, as can so often be done with firearms. And even if ice-picks were abolished, anyone could make a similar deadly weapon in five minutes by sharpening a piece of wire.

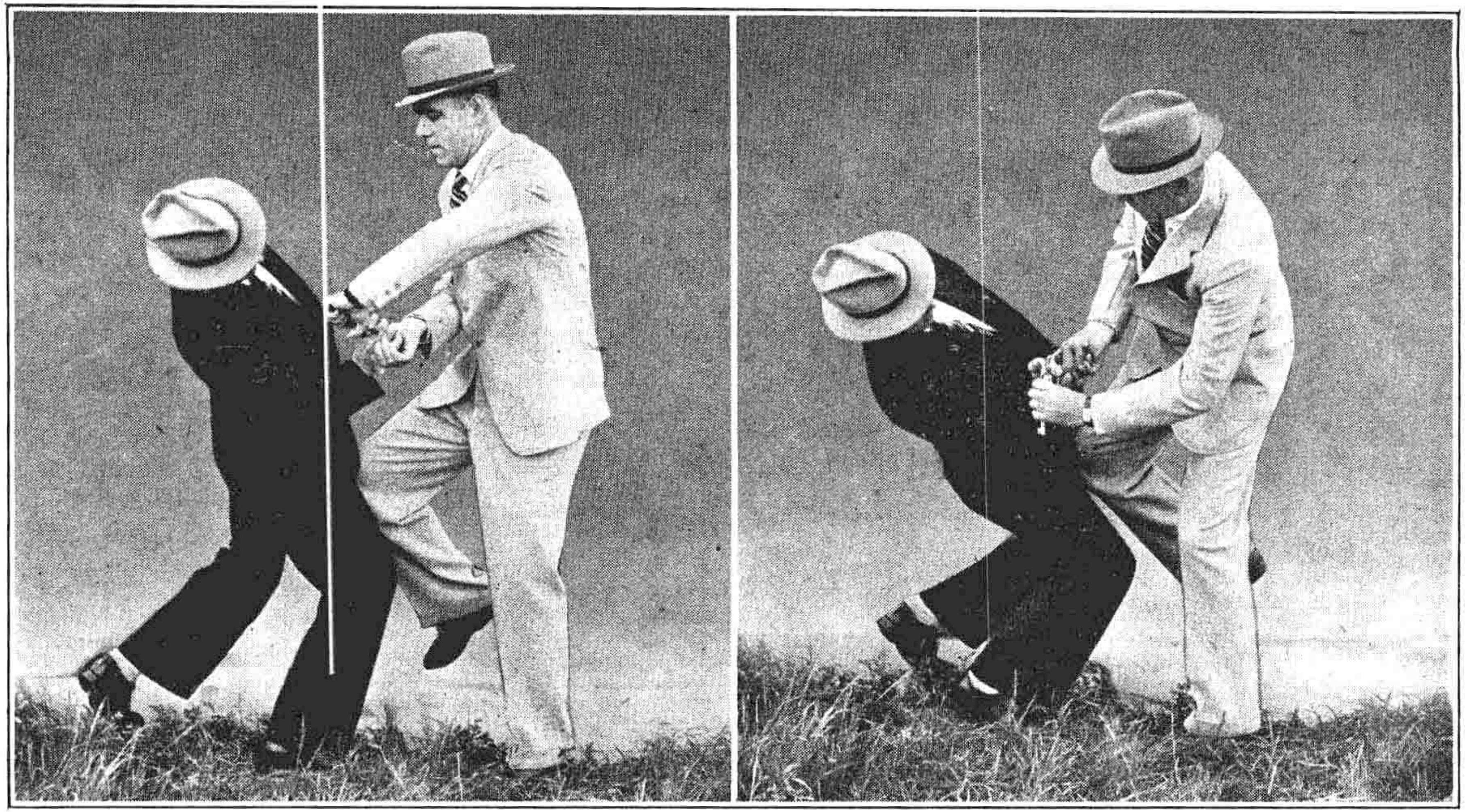
In spite of all that has been said, it must not be concluded that all legislation regulating the sale, use and possession of firearms is undesirable. On the contrary, I do not see how anyone can dispute the necessity for safe and sane laws that will disarm the



FOILING AN ATTEMPTED HOLDUP. SERIES B, WITH BANDIT IN FRONT, AND GUN POINTED SLIGHTLY TO LEFT OF CENTER OF VICTIM'S BODY.

Left: Series B, Position No. 1. Posed by Lieutenant H. Laurence Gau, Ordnance Reserve, (holding the gun) and the author. Bandit commands Hands up! and points revolver at victim, muzzle directed slightly to left of center of body. Victim starts to raise his bands.

Right: Intended victim suddenly drops left hand onto gun, pushing it to the left, and at the same time turning the body slightly to the right, so that if gun is discharged, bullet will pass by the left side. As hand is dropped onto the gun, the cylinder is grasped firmly, so that the trigger cannot be pulled unless gun is already cocked. Thumb and finger of bandit's hand grasping revolver are also grasped at the same time.



FOILING AN ATTEMPTED HOLDUP, SERIES B, POSITIONS NO. 3 AND 4.

Left: The right hand, instantly following up the action of the left as shown in Position No. 2, is placed under the butt of the gun, clasping the bandit's hand firmly in position on the handle of the gun. Then with the right hand under the butt as a pivot, and using the barrel in the left hand as a lever, the muzzle is swung sharply to the left, so that the muzzle points away at all times, and a bullet would pass harmlessly if the gun should be discharged. At the same time the bandit should be struck a disabling blow with an upward motion of the knee, as shown.

Right: As the muzzle of the gun is swung upward and to the left as described in the last position, the bandit's finger in the trigger guard will be broken, and he will be thrown to the ground by the pressure exerted on his finger by using the barrel of the pistol as a lever. The weapon will remain in the possession of the intended victim.

criminal and at the same time allow law-abiding citizens to have arms for defense.

Crimes of violence can be greatly discouraged by taking all possible steps to disarm the criminal element; but if at the same time the law-abiding element is deprived of means of defense the good effects of the law will be more than nullified, and crime will become comparatively safe, as it now is in New York and Chicago under the present laws of New York and Illinois.

The subject of legislation which will accomplish the desired result has been carefully considered by the United States Revolver Association. Some very brilliant legal talent has been obtained on the committee to consider that subject. The conclusions are that any law, to be effective, must be uniform in all States, so that it can not be evaded merely by stepping across the border.

Desirable legislation would allow anyone who does not have a criminal record to possess pistols or revolvers without restriction, but would make it a crime for anyone who has once been a criminal to possess one. Moreover, it would provide severe mandatory penalties for crimes of violence committed with firearms, and would make the mere possession of a firearm during the commission of any crime greatly increase the penalty that would otherwise be inflicted.

It would allow anyone with a clear record to purchase firearms, but would require an application to purchase to be filed at least 24 hours before the gun could be delivered by the dealer. This would prevent many of the impulsive suicides or other acts of violence that may otherwise be committed under the compulsion of emotional stress. The sale of all firearms, with the name and address of the purchaser should be recorded.

In view of all the various firearms laws now on the books of the various States, it is necessary for the householder, autoist, storekeeper, or paymaster who contemplates using a pistol for self-defense to become acquainted with the laws of his own community and obtain a permit before taking his gun in localities where a permit is required. Further, before carrying a weapon concealed for any purpose, an additional permit for carrying concealed weapons is usually necessary and this should always be obtained. In most cases valid reasons are—

First. Protection.

Second. The fact that you habitually carry large sums of money.

Third. That you habitually carry valuables; for example, jewelry salesmen.

Fourth. That you are in fear of your life by reason of threats, etc.

Such of these reasons as apply to your case, or any other valid reasons, should be quoted in applying for a permit.

Banks and Jewelry Stores

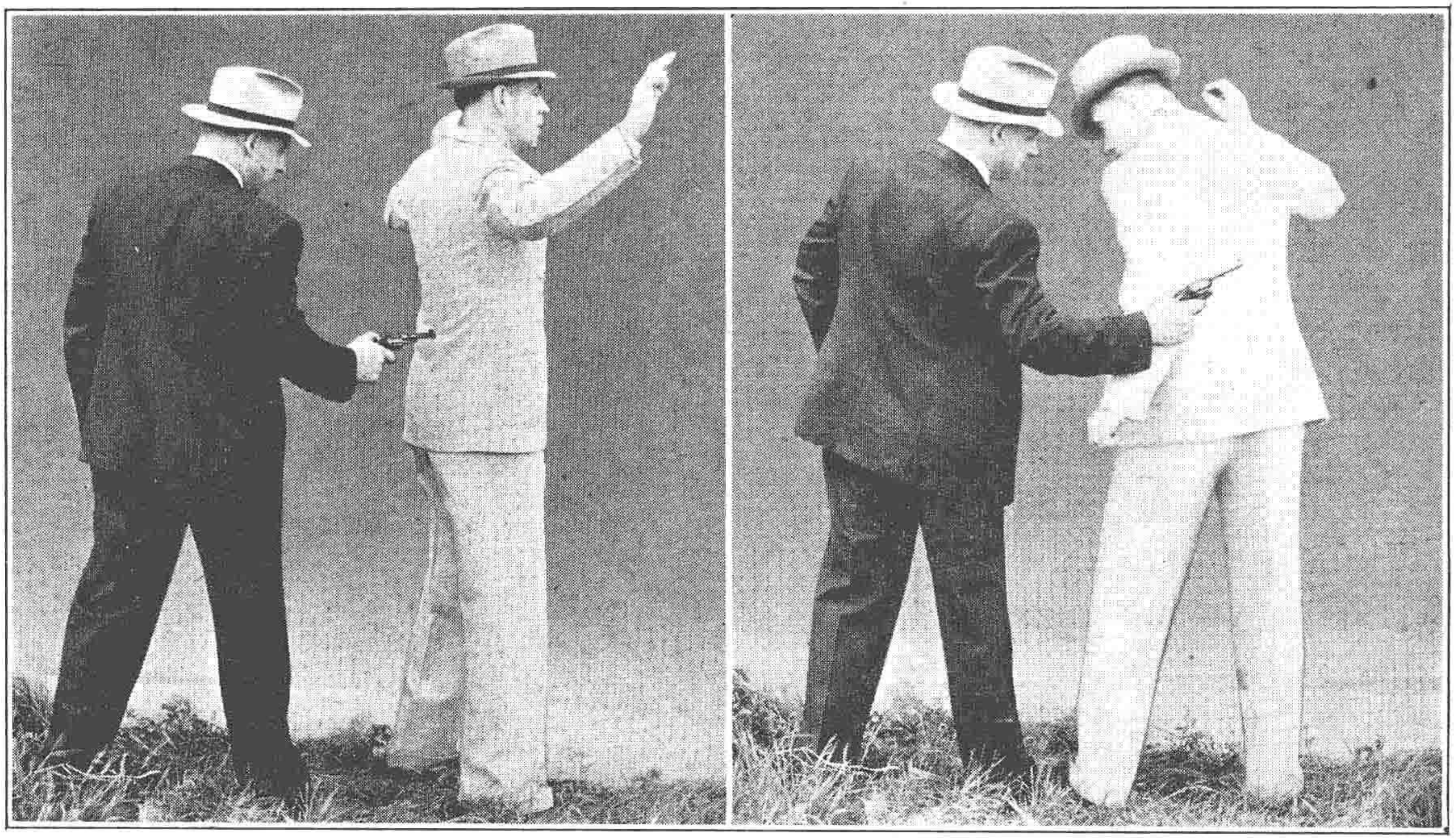
A field where hand firearms are very important for protection is in the case of stores, banks, jewelry establishments, etc. Small stores, such as drug stores, which are open until late hours at night, are particularly subject to holdups. As emphasized above, if a gun is kept it should be loaded and where it can be instantly reached. Holdups of this nature are easier to combat than those of banks or jewelry stores.

In the case of a drug store the amount to be obtained is small, and generally it is the private work of an individual or a pair who are not well organized and generally do not know how to use firearms very well.

In the case of banks and jewelry stores the possible haul for the robbers is so much greater that the robbery is usually the result of the efforts of an organized gang. It is generally hopeless for one man to try to cope with a raid of this nature. One of the best precautions is an alarm system which can be put into action at the same time that the teller is complying with the bandit's demands. In some Middle Western localities, vigilance committees have been organized for this purpose.

In a recent holdup a gang of bank robbers descended on a small town and ordered the teller to turn over all the cash he had. He stepped on the alarm button and proceeded to turn over the cash as directed, which the robbers hastily put in a satchel and then made a rush from the bank to their car, which was waiting outside, but on arriving at the door they were met by a volley of gun fire by the citizens who had responded to the alarm, and were all killed. In localities where these vigilance committees have gone into effect insurance rates have been greatly reduced.

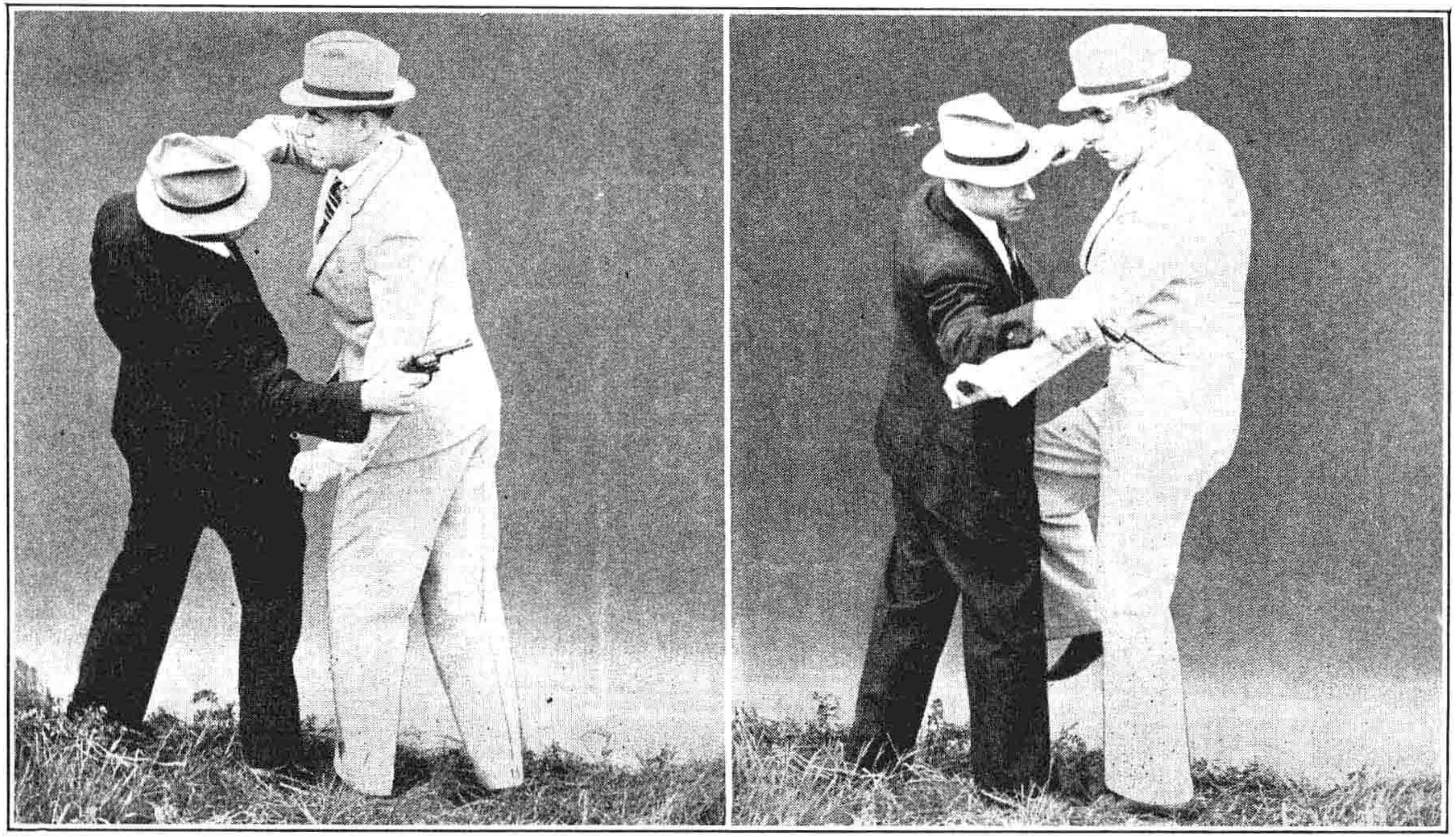
A very great protection in banks and jewelry stores is a bulletproof glass which has recently been developed which will withstand the direct charge at short range of the heaviest revolver or automatic pistol made. The writer has conducted many tests on this glass for the manufacturers of it, and the latest samples withstood successfully two shots from an Army automatic in the same



FOILING AN ATTEMPTED HOLDUP. SERIES C. WITH BANDIT BEHIND INTENDED VICTIM.

Left: Position No. 1. Victim receives command "Hands up!", and feels muzzle of revolver pressed against his back, slightly to the right of center. He starts to raise his hands as directed.

Right: The victim whirls suddenly to the left, at the same time throwing the left arm downward so as to push the gun away from the right side of the body, which is moving to the left at the same time, so that the bullet cannot strike the body when the gun is discharged. As the intended victim steps backward in whirling, to the left, he should endeavor to step on the bandit's foot.



FOILING A HOLDUP, SERIES C, POSITIONS NO. 3 AND 4.

Left: As the intended victim whirls to the left be brings his right fist crashing against the jaw of the bandit.
Right: If the intended victim is balanced favorably as he whirls, he may strike the bandit a disabling blow by an upward motion of the knee, as shown.

spot. Also, the famous German Mauser is powerless to penetrate this glass. A bank teller behind such an enclosure is perfectly safe from revolver bullets. The thicker size of this glass will withstand even a service rifle bullet, and the bandit who shoots upon it is in for a very unpleasant surprise, for the surface glass which is shattered by the impact will fly back at the shooter and cut him severely. A bandit attempting to hold up a bank and firing against a sheet of this glass would be blinded by the small pieces flying in his face, while the teller behind the glass would not be injured in any way as the glass does not come off the back.

Pay-Roll Robberies

A matter which deserves very serious thought is the subject of pay-roll robberies. Most paymasters carry a revolver, it is true, but most of them do not know anything about how to use it and they would really be better off without it. I have many times had occasion to investigate the measures that paymasters or their clerks take to prevent robbery. Frequently, especially those who carry small sums of money, will have a revolver of small caliber in the satchel along with the money. If anyone should ask them to stand and deliver, he would get, not only the money, but the revolver as well.

The only place a revolver does any good for a person who is carrying money is in his hand and actually cocked ready to shoot. If he is walking, his hand could be in his coat pocket with the gun in the hand. If he is riding in an automobile, the gun can be in his hand and his hand on his lap all ready to shoot.

Many paymasters go to the bank in an automobile, frequently in a closed car, over the same route, week after week, and they think because they do not carry much money that they will never be held up, or they think that no bandits will know that they are making these trips. Most of them consider that they are in no danger, and this is the reason why many do not take any precautions.

This is a very mistaken notion. In the first place, organized gangs of pay-roll robbers have a very well worked out system of espionage and information. They collect from every available source all the information they can on pay rolls—what kind of protection is used, what route the paymaster takes, what hours he goes, etc.—and they frequently pay well for this information and keep it for future reference. You never know when someone in your own organization may either knowingly or unconsciously give away this information to the representative of one of these gangs. Another thing is that having once obtained this information they first hold up those pay rolls that appear to have the least protection.

The paymaster may think that he can not cope with a gang of bandits anyway; so he may as well take no precautions and merely stand and deliver. This is a very dangerous attitude and may lead, not only to the loss of your money, but of your life, because these gangs are getting more and more in the habit of making out a schedule of where they will meet the pay roll, and suddenly appearing on the scene with a volley of shots, giving the paymaster no chance to put up his hands and deliver the money. They merely shoot down everybody in the way, and then get away as fast as they can with the bag.

Now it may be possible that a gang may be well enough organized to take even a well-protected pay roll, but they will not take it as long as there is one less carefully protected that they know about. On the same principle that if there are two automobiles standing on the curb, one of them locked and one of them not locked, a thief will not take the trouble to pick the lock when the other one can be driven away with no trouble. In the same way, they argue, if there are two pay rolls, one protected poorly, the other not protected at all, grab the unprotected one and take no chance of being hurt. Therefore, if you take every step possible to protect your pay roll, and let it be known that you are doing so, the chances are you will not be held up. They will take someone who is not giving any attention to protection.

Among the protective measures that are very effective are always changing the time and route at which you go to the bank, and not letting anybody know when you are going and what route you are going to take.

If you use a car do not use a closed car unless it is an armored one protected with bulletproof glass, because a closed car can be shot into by a Thompson sub-machine gun, but it can not be shot out of. Use an open car and have your messengers with their guns right in their hands. It is always best, where possible, to use two cars and have the money sometimes in one and sometimes in the other, so that it is not known which car it is going to be in.

An excellent way to avoid pay-roll holdups is to pay by check wherever this mode of payment can be used, and remember the knowledge that your pay-roll guard is receiving instruction in pistol practice never attracts any bandits.

Protection of the Home or Car

Guns intended for the protection of the home should be kept in a place where they will be readily accessible. There is no use keeping a gun on the top shelf of the closet in the spare room, or any similar place, because it will not be at hand when needed. From the situation of your own home, figure out where you will be likely to need a gun, then put your gun where it will be convenient to that place.

Moreover, the gun should be loaded, and the fact that it is loaded should be thoroughly understood and should be made known. You will never need the gun unless you need it loaded, and when you need it you will not have time to hunt up the cartridges and put them in.

Moreover, all impressions to the contrary notwithstanding, loaded guns that are known to be loaded are safest. No one takes any liberties with them. It is only with guns that are supposed to be unloaded that anyone will point at people or pretend to shoot, frequently with fatal consequences because of some cartridges that in some way remained in a supposedly harmless arm.

In a home all occupants should know where the revolver is kept; but it should be kept out of sight to prevent strangers from picking it up and handling it.

In a home where there are children they should be made to understand that revolvers are loaded and the harm they will do and generally they will never touch them. However, there are certain guns, such as the Smith & Wesson Hammerless, that a small child can not possibly discharge, and if small mischievous children are in the home this is the type of gun that should be chosen.

In the automobile the gun must be carried in some place where it can be easily reached and should be carried where it is out of sight or it will be stolen. In an open car an excellent place is in a spring holster, fastened inside the top just under the padding that is found in the curved part of most automobile tops. If you are held up you can stick up your hands as directed, then take hold of your gun. A spring holster lashed onto the steering post on top and in front of the dashboard in many makes of cars is out of sight, and is a convenient place to reach for. Remember that if your gun is not where you can get it instantly you are better off without it. Then look over your own car and find out where you can best put it.

Protection of the Person

Protection of the person involves the consideration of how best to carry a gun, and in most cases at least, it involves the carrying of the gun concealed.

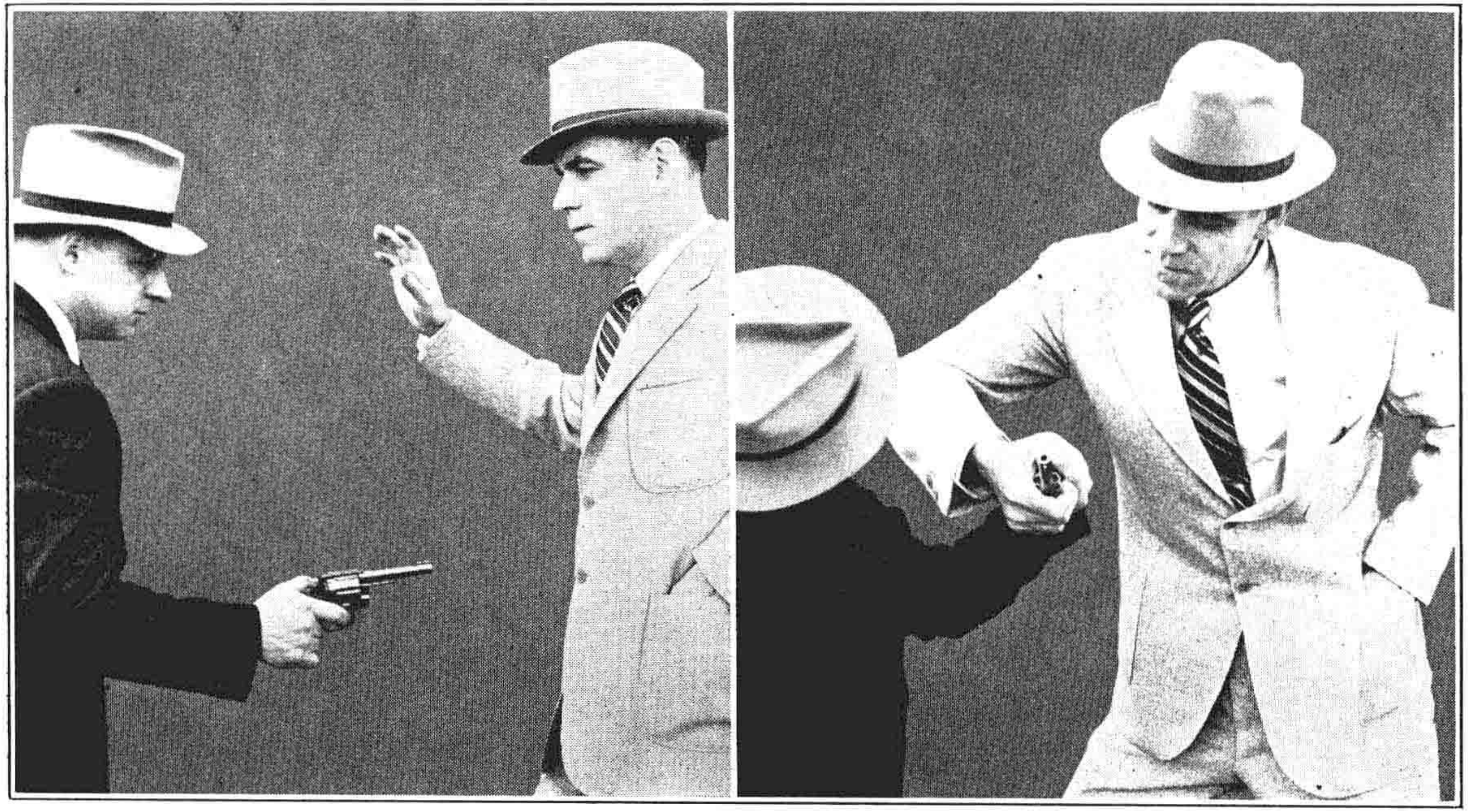
For protection against holdups the very best place to have it, and, in fact, about the only place where it will do you any good is in the outside pocket of a coat or overcoat. If you have it in your hip pocket or under a lot of clothes, there is no chance to get it when you are held up.

Holdups generally occur in lonely places and dark sections. When passing one of these have your gun in your outside overcoat pocket, your hand on it, if you have any reason to anticipate a holdup. If you are asked to stick up your hands, make out you are going to do so, start at once to raise your hands, carrying your pistol in your right hand and start to shoot. Then drop to the ground and continue shooting from that position. If in defending your life or valuables you ever find it necessary to shoot at a man quickly at close range, the point of aim should be the center of the body. If you shoot at the head you may miss, especially if it is dark and you can not see the sights. A shot directed at the center of the body is not likely to miss and, moreover, it will have a paralyzing effect if it strikes in the region of the solar plexus.

The chances are one hundred to one in your favor if you are expecting a holdup and are armed, because the success of all holdup men depends on finding their victims unarmed and not expecting anything of the kind. The majority of them are rotten shots, armed with the cheapest kind of weapons, and generally the safest thing in the surrounding landscape is the thing they are trying to shoot at, as they are pretty certain to yank their trigger and pull their gun pretty far from their intended line of aim. Moreover, the holdup man is on the wrong side of the law, and the minute an alarm is raised—for instance, if you fire a shot—he is going to get out of there as fast as he can, and that means that he will cut and run. While running he can not fire at you. On the contrary, while he is running you can stand still and absolutely bring him down if you wish to by taking deliberate aim.

Remember never to run after a man you are trying to shoot for any reason. A bullet will go as far in a second as a man will go in a minute; so instead of running, just stand still and take careful aim and you are bound to get him.

As stated above, if you are carrying a gun for a special occasion,



FOILING A HOLDUP. SERIES D, VICTIM HAS ONE HAND IN POCKET WHEN HELD UP.

Left: Position No. 1. Victim, walking with his **hand in** his pocket, is confronted by a bandit, who commands "Hands up!" **This** is a dangerous situation, for the gunman may shoot if the hand is drawn suddenly from the pocket in putting up the hands, as it **may** occur to him that the victim may have his hand on a gun in the pocket. Victim starts to raise his left hand.

Right: Foiling a holdup, Series D, Position No. 2. Bandit's entire attention is concentrated on victim's left hand, wondering if it may contain a weapon. Victim suddenly drops his right hand onto the gun, pushing it to the left, and at the same time grasping firmly around the cylinder and also around thumb and trigger finger of bandit holding the gun. As hand drops, body turns to the left, away from the possible path of the bullet if gun should be discharged. At the same instant, the muzzle of the gun is swung upward and to the left away from the body, throwing the gunman onto his back through the strain exerted **on** his wrist through the **leverage** afforded by the grip on the gun.

as for an anticipated trip through a questionable neighborhood, carry it in your outside pocket with your hand on it. However, if you are going to carrv a gun habitually concealed, there are just two places where it can be carried conveniently and effectively. One of them is in a spring shoulder holster under the left arm. This is particularly suitable for large weapons. Another place is in a small belt holster inside the waistband of the trousers, diagonally across the abdomen. When carried in this way the weapon is not noticeable, is not inconvenient to carry and can be drawn with very great speed. Moreover, this is not where anyone looks for a gun when "frisking" you.

Revolvers can be fired from the outside coat pocket without removing them from the pocket if the emergency warrants this action. In this case the aim is likely to be poor. It is good for only an extremely short range emergency. This method of shooting with an automatic pistol invariably results in a jam because the empty cartridge can not be properly ejected.

Foiling an Attempted Holdup

Everyone should know that a determined man with a knowldge of firearms can often disarm a bandit or holdup man. This requires nerve, determination, and dexterity, but there are today a dozen men in our various police forces who are teaching such methods as a matter of routine, and it is really wonderful how quickly they can get the better of an armed man.

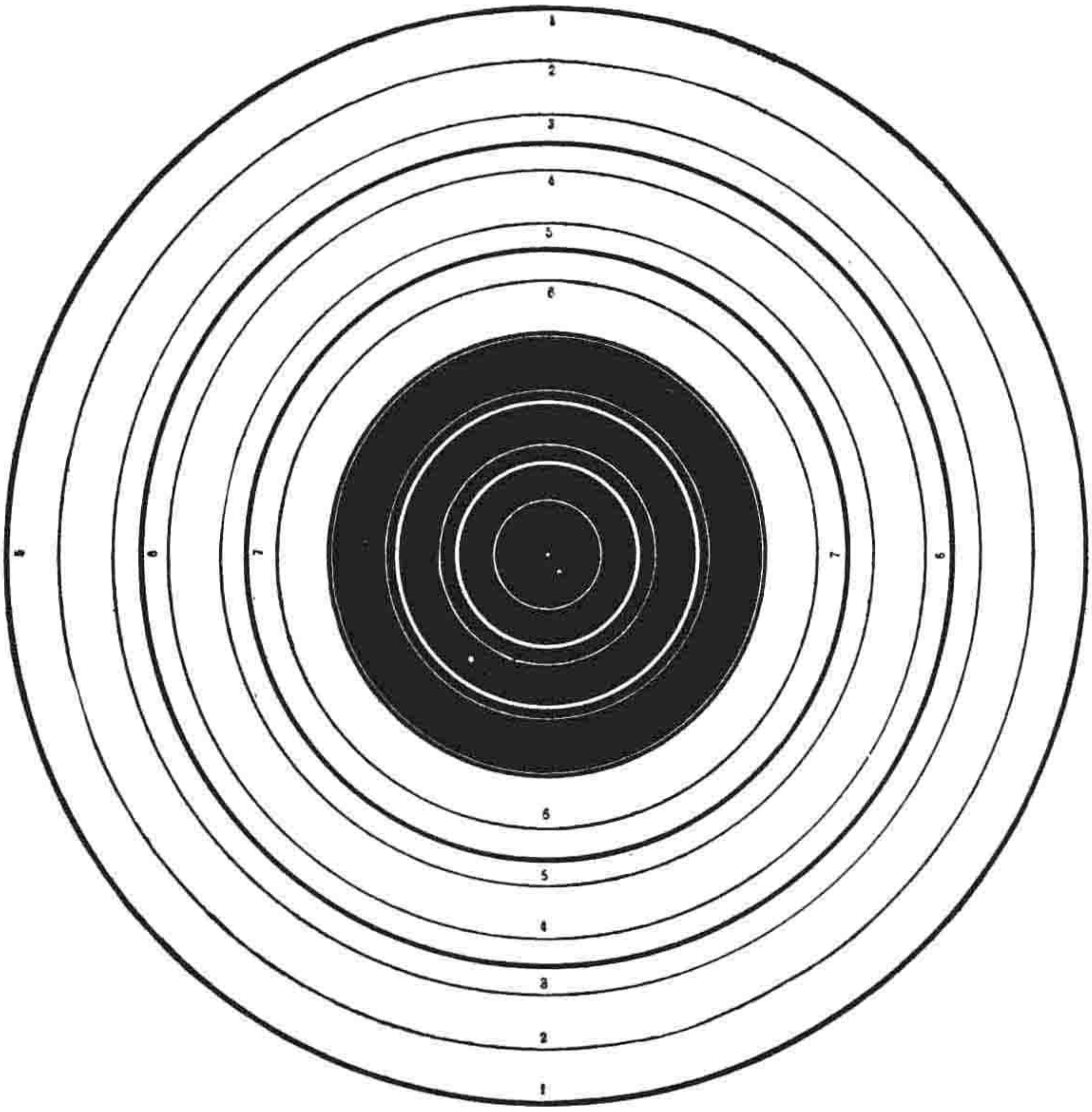
There are whole books written on this subject,* and they are well worth while to the police instructor, or to the man who is willing to take the time to study and practice this art. No attempt will be made here to go into the matter exhaustively, but a few examples are given in the accompanying illustrations and their descriptions which will show what can be done. It is well to practice each of the movements shown, but the caution is given that it must be done slowly and carefully at first, for an assistant is required, to represent the bandit, and his finger may be broken or the tendons in his wrist may be pulled very easily if the movements are executed quickly and without precautions to prevent injury to him. However, the fact that such injuries may occur is proof of the efficacy of the movements described.

The student of these exercises may never have occasion to use them, but if he has his nerve they will insure him against figuring in such headlines as one noted several weeks ago to the effect that a university athlete was held up by a girl bandit who poked a

---

*Example, *Scientific Self Defense,* Fairbairn, D. Appleton & Co., $3.50.

gun into his ribs and then marched him into a house where an assistant locked him in while the couple stole his car and money. If the young woman in question had tried that on some people that I know who have practiced this instruction, she would have wound up in jail with a broken finger and probably with concussion of the brain from being thrown onto the back of her head. One such experience would probably do more to turn a bandit's mind from the subject of hold-ups than any number of terms in jail.



THE U. S. R. A. COMBINATION TARGET.

Used in all the championship matches at 50 yards. Standard American Target rings in heavy lines. International Union Target rings in light lines.

CHAPTER 16

THE PEACE OFFICER AND HIS GUN

PROFICIENCY in the use of hand firearms is of vital importance to all guardians of the law, whether they be uniformed policemen, plain clothes detectives, or federal agents. The police officers of our large cities are, of all people, the ones who are most likely to have to use a hand firearm at any or all times.

A few years ago, the greatest menace to the safety of the police officer was the rowdy inebriated celebrant, who was likely to resent interference of his method of celebration by fisticuffs, or at worst, by throwing relatively harmless missiles such as the half of a brick. Now, however, the officer must be constantly on the alert for the dapper young man, faultlessly attired, who nevertheless is a gunman of the worst and most dangerous kind, who will shoot without warning at the slightest sign of police interest in him or in his actions.

A few years ago, the average police officer did not know very much about shooting, and did not have much incentive to learn; but the case is very different now. The National Rifle Association has co-operated fully and efficiently with the heads of the larger police departments in giving marksmanship instruction to the various members of those organizations; and the men, as their interest has become aroused, have responded by becoming the finest body of pistol marksmen, as a whole, in the world. In most of our revolver matches today, the majority of the honors go to police officers. Of course there are still hundreds of small town policemen who have never had the opportunity or the desire to learn to shoot; but the average city police force is now highly efficient in the use of hand firearms.

Nevertheless, the attitude of the press and of the public is all too often one of criticism of the Police Officer and his method of handling his gun.

This is because with the hundreds of thousands of policemen in this country being constantly obliged to cope with bandits of all kinds in crowded cities there are bound to be rare cases where someone else gets hit with a policeman's bullet besides the thing he aimed at. The thousand times he hits what he aims at with his gun or accomplishes his purpose is not "news," and very little notice is taken of these incidents in the press; but if the thousand and first time he shoots, the bullet hits an innocent pedestrian who comes around the corner just as the holdup man reaches it, this, or any other similar untoward accident, is big news and the most is made of it, not only by the newspapers, but by many other self-appointed critics.

Recently, in the case of the shooting of the desperado John Dillinger in Chicago by two Federal Agents, much criticism of the Department of Justice, and of the authorities generally was seen in the press because two women were slightly wounded. The impression given by these accounts was that there was a volley of random shots fired by the officers, striking the outlaw as well as everyone else in that general vicinity. Actually, as the outlaw drew his automatic pistol from his pocket, the Federal Agents fired three shots, one of them striking Dillinger in the left eye, one in the heart, and one just below the heart. These latter two bullets struck a brick wall, and one of them inflicted a flesh wound in the leg of a bystander, while the other caused a chip of brick to strike the ankle of another innocent passerby. The injury to these two victims was unfortunate, but unavoidable. The emergency made it imperative for the Federal men to shoot immediately when Dillinger drew his gun, not only to save their own lives, but to avoid a gun battle in the crowded theatre district, with no one knows how many possible fatalities. They acted with superb efficiency and marksmanship, and only bad luck caused the two bullets to do further damage after passing through the body of the outlaw.

Let us take a look at this whole subject of policemen and guns from the Police Officer's viewpoint, and see if there isn't another side to it. Let's dismiss for the moment the fact that ninety-nine out of a hundred of the critics themselves know nothing whatever about shooting. Let's look at it for a time as against the police officer and the man who actually does know something about shooting. The self-satisfied marksman takes a black paper bull's-eye, beautifully outlined against a perfectly white target at a fixed distance of 50 yards, and what is more, his target is usually standing absolutely still. If he can hit this there is real cause for congratulations, because the large majority of our citizens that have not tried to do it would hit the ground halfway to the target. We thus see that it is a fairly hard job to hit an ideal target of the type mentioned; but let us compare the target that the policeman has to shoot at. Nine-tenths of the time it is a moving target, and a rapidly moving one at that, for a policeman does not shoot at a man who is standing still. He only shoots when the criminal is trying to get away, or is drawing a gun, or committing some other overt act, and when a criminal is committing some such act he is far from being still. He is a moving target, and a rapidly moving one at that, and nine times out of ten he is a very indistinct target, for he is either in the dark, where neither he nor the sights of the gun can be seen by the policeman, or he is in a rapidly moving automobile trying to get away, or else he is around a corner or making his escape through a crowded street.

Even the average expert marksman when confronted with a job of target practice under those conditions, would be absolutely flabbergasted, and add to it that your target is shooting back at you, and you have a combination that is not at all conducive to the finest results as to marksmanship. As to the question of shooting innocent bystanders, make a mental picture of a bandit making his get-away in any down-town street of some of our big cities, and you will see that the criminal is silhouetted entirely against targets that will be damaged if the bullet misses him or if it goes entirely through him.

A most unfortunate phase of this situation is the fact that the law gives the criminal the first shot at the policeman in every case. This seems like a queer statement, but a little reflection will show how true it is and why. The police officer can not start shooting before he has attempted to make an arrest quietly; but the mere fact that he is approaching a criminal puts the criminal on his guard, who at once makes up his mind whether or not he wants to shoot; and the officer can not start shooting unless the criminal starts the trouble, and by that time the officer is at a big disadvantage. As a matter of fact, the policeman's job in any of the large American cities is an extremely dangerous one. The casualty lists of policemen killed or wounded in the performance of their duty has grown so common in the daily newspapers that they pass almost unnoticed by the average citizen.

A policeman never knows when he may be up against a proposition like this: Just recently the newspapers in Philadelphia carried an account of a policeman who saw a car with four occupants speeding down one of the well-known streets of that city at an early hour in the morning. He commandeered a taxicab and overtook the car; halted it and started to ask the driver his name. Another occupant of the car stepped up behind him and shot him without warning and for no apparent reason. But I am glad to say he was caught and executed.

Another example is the case of Sergt. Frank S. Harper, of the Los Angeles Police Department. Several years ago he located a car said to have been stolen, and while watching it saw a well-dressed man about to enter it. He went up to the car and asked the man for his name and driver's card. Without a moment's warning the man whipped out a revolver and shot the officer through the shoulder. However, he picked the wrong man this time, for Sergeant Harper was a graduate of the recently established School of Marksmanship, conducted for the Los Angeles Police Department, and was an expert rapid-fire pistol shot. As he was falling he drew his gun and fired five times. Four of the shots pierced the bandit's heart and lungs and the fifth went through his hat. We are glad to be able to record that the sergeant recovered very promptly from his wound and was decorated for bravery.

These two incidents show extremely well at what a disadvantage the ordinary patrolman is placed. Neither one of these two men had any reason to anticipate shooting. They couldn't even draw a revolver and approach the other man thus prepared because the presumption was in both cases that the driver was a reputable citizen, and if the police started the habit of going up to reputable citizens whom they had to question, with a drawn revolver in one hand, their job on the force would not last very long. The moral of these incidents is that the public places the policeman in a position of deadly peril, and his only hope when danger comes is to be able to use his revolver accurately and use it quickly. For him to have an even chance he must be trained in the use of hand arms, and his training must not be merely perfunctory, but must be so thorough that his use of the pistol will be instinctive and automatic.

It is the duty of the public, who places these men on this dangerous duty, to provide them with facilities for getting training. The policeman can not do this for himself. In the first place, he has neither the time nor the money to spend on pistol practice, because he is a hard-working individual, his hours are long and his pay is small. He can not afford to use up in pistol practice the few hours that he has off duty and in addition put up from three to four cents a shot for cartridges out of a salary that probably is not sufficient anyway to keep up life insurance for his wife and children against the time when the other fellow gets in the first shot. Suppose, however, that he does decide to take off the necessary time and put up the necessary cash to perfect himself in shooting. Just where would he practice? Pistol-shooting is something that you can not do in your own back yard in a city. Suppose that he decides to take enough time to take a street car out to the country. Even that is questionable, because there are very few places in the vicinity of a large city where indiscriminate pistol-shooting can be practiced. In many parts of the East you can ride by street car or automobile from one large city to another and never be out of sight of a house.

The answer is that unless the public does its part the police officer will not be trained in one of the most important parts of his profession, which is the quick and accurate use of hand arms. This is becoming more and more realized in late years, and most of our municipalities have established revolver ranges for the police, where a regular course of instruction is given to all members of the force. The instructions come during the hours of duty, and the necessary ammunition is paid for by the city. In places where this has been done the results have been remarkable in the reduction of crime. Gangsters and gunmen will not stay in a city where the police force has a reputation for quick and accurate shooting when there is another city near by where there is a poorly trained police force. An example of what happens to a crook in such a place is well illustrated in the incident of Sergeant Harper, given above.

Another important result of this policy has been to greatly reduce the premiums for burglar insurance in many localities where this training has been given. This item of insurance reduction alone is great enough to pay for the total cost of the instruction many times over.

The problem of training a police force in shooting is rather a big one for several reasons. One of them is that nine times out of ten the policeman must shoot in the dark or in a very poor light and cannot see the sights of his gun. His targets are practically moving targets, and moving quickly at that. In a great many cases they are shooting back at him. It means that he must undergo the most difficult sort of training in order to be able to win out in a game like this.

Primary Requirements

As a matter of fact, before the training of the Police Officer even starts there are certain other requirements that must be met. In the first place, he must have a suitable weapon. Rapid progress has been made along this line in the last few years. A few years ago the police officer was allowed to carry any gun he wanted to. Of late years, however, the subject has received a considerable amount of study and in many police departments there are excellent requirements as to the type and caliber of arm to be used.

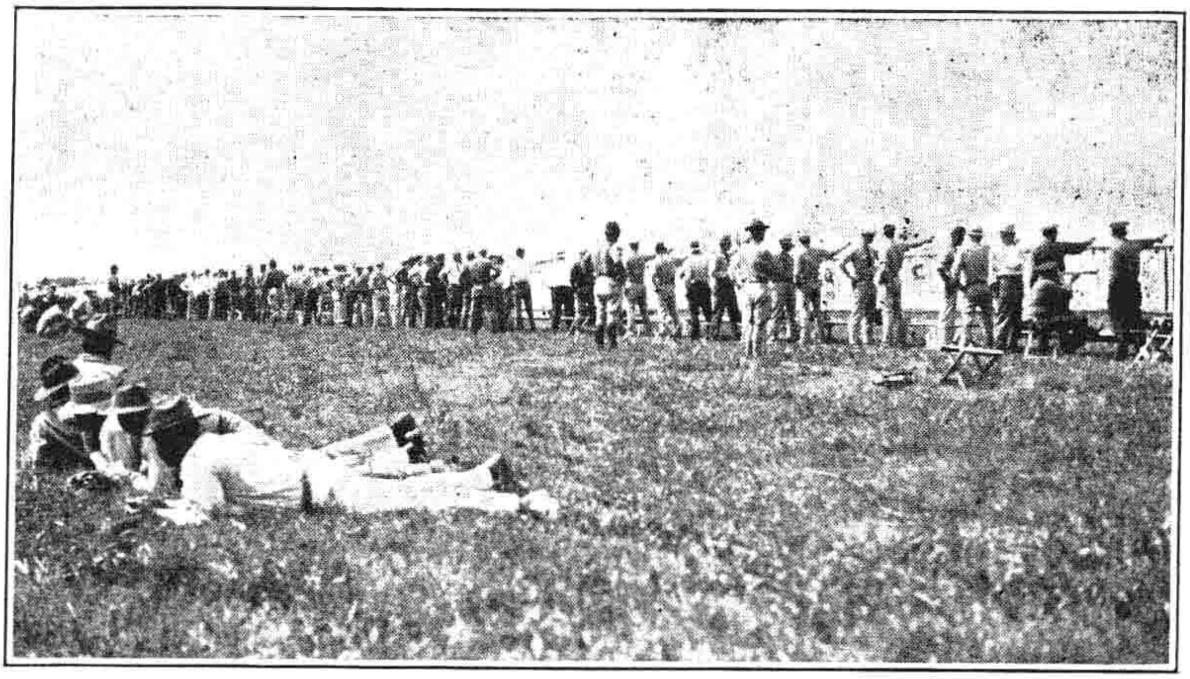
The first requirement is that the gun should be of sufficient caliber to have ample stopping power. This means that it should not be smaller than a .38. Only the highest grade of pistol or revolver is good enough for the use of the policeman who may owe his life to the functioning of his gun. All guns in a police force should preferably be of the same kind and caliber. There is no telling when an officer may have to use a comrade's gun, and if they are all of the same make there will be no failure owing to unfamiliarity. Among the uniformed members of the force the only place a gun should be carried is on the outside of everything else, where it can be got out easily without having to get under an overcoat and a lot of other clothes to get at it. It should be carried in an approved type of quick-draw holster. Every man on the police force should be taught at city expense, and on city time, to use his gun proficiently, and after he has obtained proficiency he should have actual firing practice at regular intervals to keep up his knowledge. This practice should also, of course, be on city time and at city expense.

There should be a certain allowance of ammunition for every member of the police force armed with a revolver or pistol, and there should be a requirement which will provide that old ammunition be used up in practice and that new ammunition will be kept available for actual service use. Unless this point is watched the officer may carry the same old cartridges in his gun, and then from the effects of dampness or oil soaking into the cartridges they may fail at the critical moment.

Carrying cartridges openly in a cartridge belt is a practice not to be recommended for the police force. In one of our large Eastern cities the regulations require each member of the force to carry twelve cartridges in this manner in the holster belt, which is worn outside of all other clothes. These cartridges must be kept shined up for inspection, and there is plain evidence around the primers in many cases of the metal polish that has been used to keep their cartridges bright and shiny. This metal polish generally contains gasoline, which will ruin the primer if any of it soaks in. The cartridges are carried in the belt, primer end up, and naturally the primers will be the first place for moisture to collect in any rain or dampness, and if the waterproofing is not perfect or if it has been removed by the polishing of the cartridges, it is conceivable that the ammunition may fail when needed, with possible disastrous consequences.

Marksmanship School for Police

The instruction that the police should receive in the handling and use of hand arms should include full information on the different kinds of firearms, how they are made, the names and functions of each part, and especially safety precautions, and how to handle them without danger of accident. This instruction should be followed by the teaching of proficiency in both slow and rapid fire as described in Chapter 13. This training in target marksmanship will form only the groundwork on which the policeman's real pistol training should be built. This target training gives him a confidence in his arm and an ability to let off shots without disturbing his aim. It gives him the co-ordination of the shooting hand and arm that will never be obtained in any other way.



The National Rifle Association Police School at Camp Perry. Police Officers on the firing line executing "Rapid Fire."

After this regular marksmanship training has been learned the next thing is to teach him rapid fire, using the sights, and after that, rapid fire without using the sights. Then he must be taught all kinds of emergency firing, such as shooting at night, in dark hallways, etc. His training must be so thorough that at any time he can point his gun at an object in the same way that you can point your finger and that this can be done automatically and without thinking of the sights at all. A course of pistol training should include the above-mentioned subjects in about the following sequence:

1. Description of pistols, and instruction as to handling and safety precautions.
2. Explanation of sights and sighting, followed by aiming exercises.
3. Instruction in the method of holding the gun, followed by snapping exercises.
4. Slow-fire practice with the .22 caliber until proficiency is attained.
5. Slow-fire practice with full charges.
6. Rapid-fire—aimed shots.
7. Rapid-fire without using sights.
8. Instruction in drawing the gun from the holster—practice in drawing and shooting at "Man" targets.
9. Drawing and shooting at moving targets.
10. Raid practice.

A description will be given of each of these headings.

1. The student should be given a simple description of the principle of firearms and of the different kinds of arms, such as automatic pistols, single-shot pistols, revolvers, etc. The principles of construction of the various arms should be explained and the reason for the different parts, such as the hammer, trigger, cylinder, rifling, etc. The difference between right- and left-hand rifling should be explained, and the student should be shown bullets that have been fired from guns, with rifling marks on them. The cleaning and care of the gun should also be fully explained For information on these points the instructor is referred to Chapter 5.

2. Aiming exercises. The instruction and use of the various sights should be explained and the student should be put through a course of aiming triangles as described in Chapter 13.

3. Method of holding, and snapping exercises. This subject is also fully described in Chapter 13, and instruction will, of course,

depend somewhat on the type of arm with which the force is equipped.

4. The practice of slow and rapid fire should also be taught as described in Chapter 13.

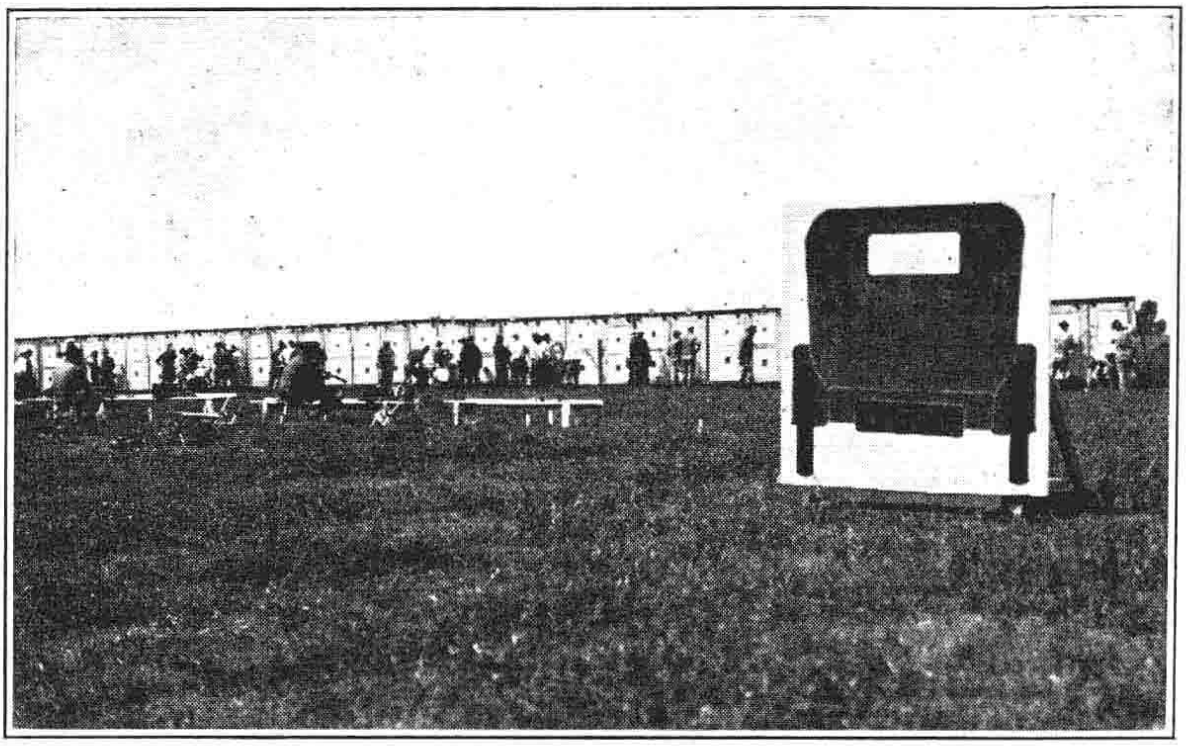
7. This brings us to No. 7—rapid-fire without using the sights. This is a course of practice which is particularly necessary for the police. The student should be taught to face his target squarely at all times and to swing the arm directly up in line with the bull's-eye, letting the shot off as soon as the arm reaches the horizontal position. For success it is essential that one particular grip on the gun be learned and be adhered to. For this practice it is advisable to use a 50-yard standard American target placed about 5 yards away. Facing this target, the arm holding the revolver should be swung up straight toward the target from the position of the holster on the belt, cocking the gun as it is swung up, and when it is in line with the bull's-eye the trigger should be pulled. It is well to practice this extensively before doing any actual shooting in this manner. In actually shooting at this target shots must be expected to hit the floor at first and sometimes to go to either side of the target or above it, so it is well to hold this practice in a place that is arranged so that no damage will result if some of the shots do not strike the target. After practice is had in simulating fire of this kind actual shooting should be done, one shot at a time until such proficiency is reached that the shot can always be placed in the bull's-eye. It will be found that with a little practice quite a knack can be acquired, so that swinging the arm upward and letting the shot off at the bull's-eye is almost like tossing a ball at it. When this point is reached the secret will have been mastered.

8. Instruction in drawing and shooting at the "Man" targets. The best targets of this kind are the Langrish Limbless target and the Colt Police Silhouette target. Both of these targets represent the outline of the upper part of a man's body, and they have various scoring zones with different values accorded the hits. The man target should be placed about 5 yards away for the first practice. Before beginning the practice the student should be carefully instructed in regard to holsters, the manner of drawing, and cocking the gun while drawing, and then should be allowed to practice with an unloaded gun at this target until smoothness in getting the weapon into action is attained. Afterwards this practice should be conducted with one cartridge in the gun, shooting one shot at a time at the target. After proficiency has been obtained in rapidly

putting one shot on the target, the distance should be increased to 10 yards, and the practice repeated. Finally, the target should be moved to 15 yards, and the marksman should be required to fire six shots, slow fire, keeping the shots in a small group in the center of the figure.

Next, rapid fire should be practiced, cocking the gun for each shot; then rapid fire, using the double action; that is, cocking the gun as well as firing it, but pulling the trigger.

When the officer under instruction can draw his gun and fire six shots into the center of the man target at 15 yards in ten seconds he will be a formidable antagonist for anyone in a gun-fight.

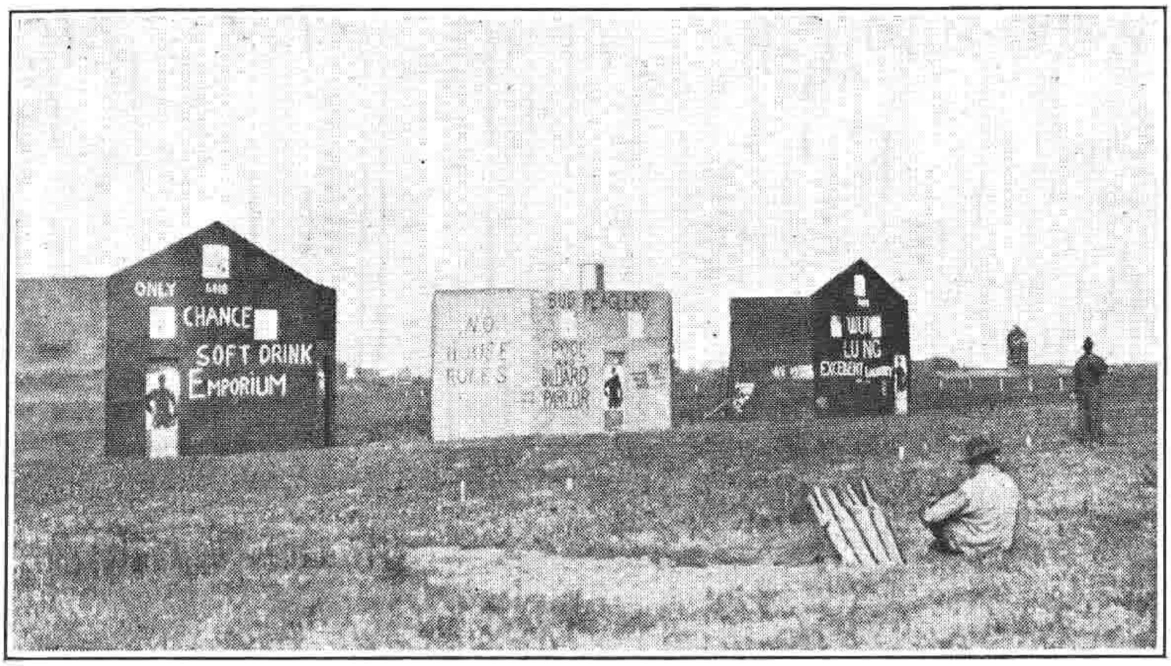


Police Training School conducted by the National Rifle Association at Camp Perry. Police officers examining the targets and recording the scores after a string of "Rapid Fire." Note the automobile target in the foreground. It is arranged on a track so as to move rapidly away from the firing line. The body of the car is buff, but the important aiming points, such as the tires and gas tank are black.

9. Practice with moving targets. For this purpose the target carrier is arranged to travel on a trolley in a line parallel to the firing-point. On this traveling target clamp a Colt Man target is hung. The trolley for the target carrier to travel on is arranged to travel across an opening about 10 feet wide, the target being about 10 yards away. In the first practice with this traveling target the student loads his gun with one shot and stands ready, gun in hand and cocked, and the target suddenly appears and travels across the opening. During the time it is traveling across he is supposed to place the shot somewhere in the target. After proficiency is ob-

tained with one shot the student is allowed to load his gun fully and see how many shots he can get in while the target is traveling across. The last practice with this traveling target consists of allowing the student to have his gun in the holster loaded with one cartridge. As soon as the target appears the shooter draws his gun, cocks and fires one shot.

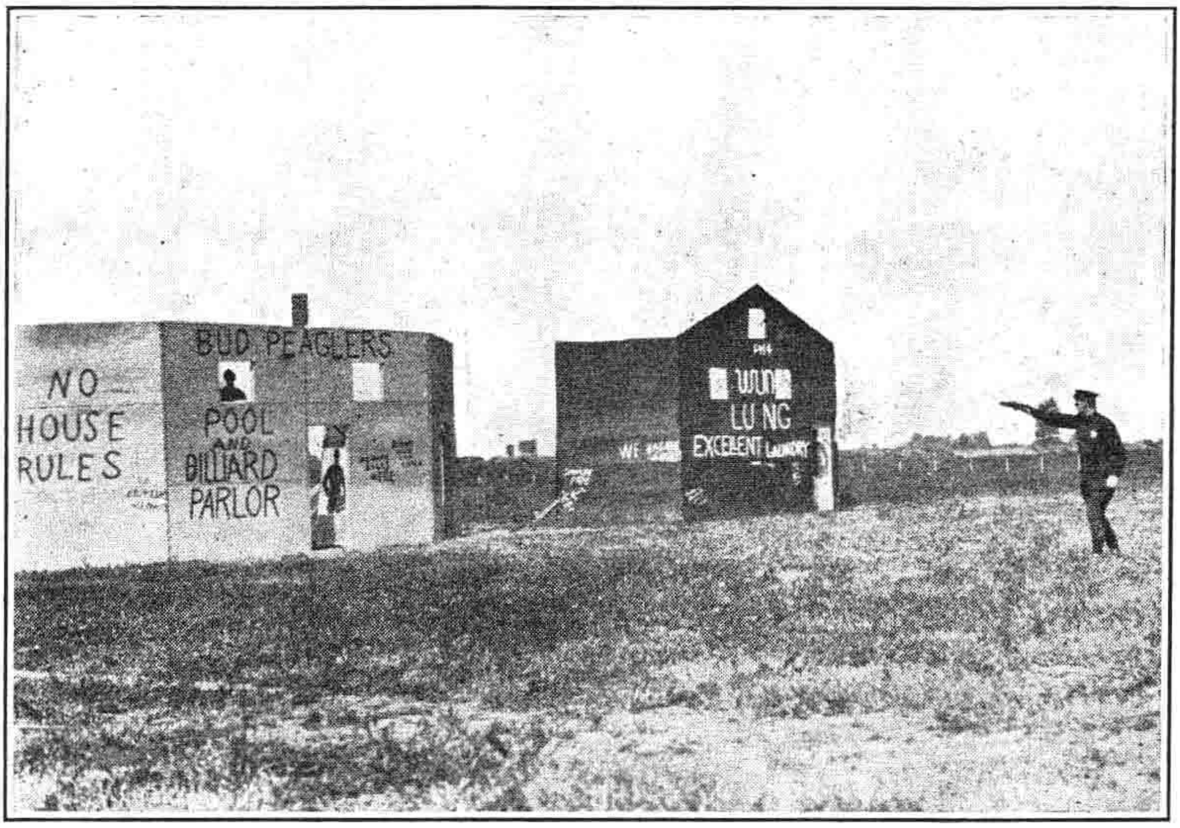
10. The last practice in this course is the "raid" practice, representing conditions encountered in raiding a dwelling or vice den of any kind. This course is taken from the description given by Commander Baum in the December 1, 1924, *American Rifleman,* where he states:



"Hogan's Alley" at Camp Perry. By pulling the levers the operator can make figures appear at unexpected places in the doors and windows, and from behind the chimney of Bud Peagler's Place.

"This string is fired inside of a bombproof to prevent wild shots from injuring anyone. The shooter takes his position outside of a door which leads into a dark passageway. Upon opening the door he is permitted to draw and cock his pistol. The passageway is dark and littered with chairs, boxes or short stairs, in fact, many things to cause extreme care in walking. At the end of the passageway is another door leading into a dimly lighted room. Immediately he steps into the room he must be prepared to shoot at whatever target he sees representing a human being. As soon as the shooter clears the threshold, firecrackers, confetti, sticks or other objects are thrown at him; then someone yells into his ear, pistols are fired behind him and everything possible is done to shake his nerve and disconcert him. A target representing the head and shoulders of a man swings out from behind a wall, remaining in sight only momentarily, a moving target slides across the end of the room, and a head is dropped into the room from above to represent a man springing down. Only three targets are shown and the shooter is permitted only one shot at each target."

There are not many places where the exact course suggested by Commander Baum can be arranged, but the general idea may readily be grasped from what he has said, and something of the kind is exceedingly valuable in rounding out any course of marksmanship and in making a really practical police shot.



Police Officer practising in "Hogan's Alley," at Camp Perry. A figure has just appeared in the window, and another will appear in the door in an instant.

Something on this general order is found in the so-called "Hogan's Alley" range which is part of the great Police School conducted by The National Rifle Association at Camp Perry each year. This is an outgrowth of the "French Village" at the National Matches at Caldwell, New Jersey, in 1919, just after the close of the World War. This French Village was constructed by Captain Deming, who was an artist by profession, and during his war service contributed much valuable material in the way of landscape targets. He made a section of canvas representing part of a ruined village in France, with houses, streets, etc. Back of this there was a pit for the scorers. Each of these scorers had a cardboard figure, resembling the head and shoulders of a man, nailed on the end of a long stick. The shooter took his place at the firing-point, gun in hand. Suddenly, at the windows or the corner of a wall, or some other unexpected place, one of these figures would be poked up and exposed for three seconds, then withdrawn. The firer never knew just where a figure was going to appear. It was his business to watch for these figures and the instant one appeared to shoot it. This is a very hard thing to do, and it shows up different shooters in different ways, which is quite a revelation. It is especially confusing when two figures are shown at different parts of the target. This is actual practice for quick shooting with the pistol already in the hand. "Hogan's Alley" consists of several sham buildings erected on the target line, to represent a street in a slum section of a town. There are, of course, numerous doors and windows, and there are chimneys, etc., behind which gangsters might be supposed to be lurking. The officer under instruction walks down the street, with his gun loaded. There is a target operator with a number of levers at his command, by means of which he may cause silhouette figures to appear in the various doorways and windows, and to lean from behind the chimneys on top of the various buildings. As each figure appears in some unexpected place, the officer fires at it. His endeavor is to place a shot on every figure that may appear.

A man who has been intelligently put through a course of instruction similar to that described under the above headings will be a very dangerous adversary indeed and will get the better of any gunman in a shooting fight. The description given above is only an outline and is intended to be modified to suit various conditions. It should be supplemented with as much general instruction on the subject of firearms and their use as can be made available.

Useful Knowledge

There are many things that it would be very useful for the policeman to know about the use of guns. For example, in moving-picture shows the commonly accepted method of intimidating one with a pistol appears to be to push it against his ribs in readiness to shoot. The user of an automatic pistol should know that when the muzzle of the gun is pressed hard against any object the slide is pushed back slightly and consequently the gun cannot be discharged at all.

Again, if a revolver is pointed at you closely enough so that you can grasp it tightly around the cylinder it is impossible to cock it because in cocking the revolver the cylinder must rotate.

This danger is avoided if when approaching a man to effect an arrest with drawn gun you advance toward him left side first, with the right hand holding the gun near your own body, pointing at the prisoner, but well back away from his reach. If he should make a move for your gun, you can hold him out of reach of it with your left hand, as you fire with your right. This may sound cold-blooded, but as you value your life, never approach a man with a gun in your hand unless you have made up your mind to shoot if necessary, and then at the first sign of trouble let him have it.

Moreover, if you are known to be armed, don't draw your gun until the case demands drastic action and you are willing to shoot. Unnecessary display of a revolver weakens your position. But if you do have to draw a gun in making an arrest, take the offensive, and walk boldly up to your man. Somehow the fact that you have made up your mind to shoot at the first violence not only settles your own mind and makes you act with more force and decision, but it also communicates itself to your opponent and, so to speak, "gives him a chill." If you have fully made up your mind to shoot if you have to, the chances are that you will not have to.

The revolver is also a useful weapon in a hand-to-hand fight, even if not loaded. It can be used very effectively to strike an assailant with, and for this purpose it is not necessary to turn it around in the hand and strike with the butt, instead strike with the barrel, especially if it is a heavy gun, such as the .45.

In towns where gun-fights are common one of the most noticeable things to a stranger is that at the first shot everybody gets down as flat to the ground as possible. Once, in a Western town a good many years ago, I saw a "bad man" shoot up a restaurant by firing all the cartridges in his revolver into the door at random because the proprietor would not cash a check for him. I was passing when the first shot occurred, and what I noticed most was that at the first shot everyone in the street was down as flat as possible and most of them were in the gutter. The man was standing in the door of the restaurant firing his gun into it, and just as he got the last shot fired he was collared from behind by a soldier belonging to the Army detachment stationed there at that time and was dragged off to the lockup. His exhibition of fire-works did no harm aside from putting a few holes in the walls and ceiling of the restaurant, because at the first shot everybody in the restaurant was down flat on the floor. A number of other times when I have seen shooting affrays in places where they were common I have been impressed with the fact that everybody gets down as quickly as possible and that often no one is hurt.

There is a lesson in this. If you are mixed up in a gun-fight of any kind and have to stay in one place the best thing to do is to get down as low as possible, as you can fire a gun just as well from this position and your chances of being hit are practically nil. Another good thing to remember is that if, for any reason, you do not get down, do not stand still when somebody is shooting at you. Either move toward him or away from him, or side-wise, but move in some direction and move as rapidly as possible as this will disturb his aim. Stop when you are going to fire, because you can fire much more effectively when you are still. Never shoot while you are running after a man. If you shoot while you are running your fire will be ineffective. If you are trying to stop a running fugitive, stand still and take deadly aim and you will get him every time as a bullet can overtake a running man very easily.

If you ever have to fire your gun to scare anyone or as a warning, never fire it onto the pavement, as the bullet will bounce and may kill someone. The safest way to fire it is almost straight up, because then the bullet will spend most of its energy overcoming air resistance and will fall harmlessly to the ground.

The author shooting Mr. R. F. Sedgeley's Colt New Service .22 Hornet.

INDEX

A

Accessories, 240
Accuracy, 160, 392
Accuracy Tables, 393
Ace Pistol, 64-74, 169
Adjusting sights, 183, 186, 470
Adjustment tables for sights, 187-188
Adjusting trigger pulls, 193
Air Pistols, 11-16
"Alfa" revolver, 138
"American Rifleman," 148, 209, 525
Ammunition Technical Notes, 383
Antwerp, 456
Area of bullets, Table, 431
Army Special Revolver, 45
"Astra" pistol, 139
ATCSA pistol, 136. 137, 138
Audley Holster, 241,242
Automatic Pistols, 3, 4, 5
Automatic Colt .45 Gov't Model, 91
Automatic Vs Revolver, 5
Auto-rim cartridge, 86

B

Baker, Milford, 478
Ballistic Coefficient, Tables, 313
Ballistics, Exterior, 309
Ballistics, Interior, 287
Banker's Special Revolver, 119, 120, 156. 157
Banks. Protection of, 503
Barnes. M. H., 478
Barrel Dimensions, Table, 145
Barrel Length. 17, 147
Barrel Life, 222
"Battle Practice," 484
Bausch & Lomb Optical Co., 248, 259
Bayard Automatic Pistol, 134
Beckeart, Phil B., 39
Beckeart Model Revolver, 39, 43, 159
Belgian Automatic Pistols, 133
Beristain & Co., 140
Berns, J. E., 244
Berns-Martin Holsters, 242-244
Bisley, England, 32, 35, 152, 149, 451, 468
B. S. A. (Birmingham Small Arms) Air Rifle, 11, 12
Blank Cartridges, 396
Blank Cartridge Pistols, 10
"Blow-back" Mechanism, 5
Blow, Firing Pin, 164
Blow, Firing Pin, Tables, 166.
Borchardt, 102
Bore & Groove Dimensions, 34
Bracken, R. C., 257, 455, 478
Browning, John M., 59
Browning Pistols, 130, 133
Buchel, Ernst Friederich, 36
Buchel Pistols, 36, 37, 200
"Bufalo" Pistol, 140
Bullet Diameter, Effect of, 428
Bullets, General Information on, 279, 397
Bullets, Manufacture of, 282
Bullet Material, Effect of, 427
Bullet Shape, Effect of, 409, 427
Bullet Stops, 265
Bullet Weight, Effect of, 404, 427
"Bullseye" Pistol, 463
Burchan, Lieut. Clyde A., 477
Burst Guns, 213-216
Butcher, Col. Edwin, 414

C

Caliber, 1, 276
Calkins, Dr. I. R., 58, 478
"Call" Sight, 44, 181
Clement Automatic, 134
Camp Perry, Ohio, 4, 33
"Camp Perry Model" Pistol, 24, 41, 45, 169, 197
Care & Cleaning, 227
Car, Protection of, 508
Carpenter, E. S., 478
Carrying Case, 246
Capacity, Cartridge Case, Table of, 288
Cartridge case Capacity, Table of 288
Cartridge Life, 384
Cartridges, General Information on, 275
Cartridges, Individual Description of, 323-382
Cartridges, Listed by Caliber, 323-382
Cartridges, Manufacture of, 281
Cartridges, Rim & Rimless, 277
Cartridges, Types of, 277
Caspi, Antonio, 413
Casts, Material for Making, 147
Chamber Casts, 147
Chloroil, 229
Case, Carrying, 246
Chronograph, 309
Cleaning Material, 249
Cleaning Rods, 250-253
Codrington, Lieut.-General Sir Alfred, 262
Colt "Ace" Pistol, 64, 169
Colt "Army Special" Revolver, 45
Colt Army .38 Revolvers, 77, 80
Colt Automatic Pistol, Government Model, 91-96
Colt Automatic Pistol, Pocket Model, 124, 125, 132
Colt Automatic Pistol, Vest Pocket Model, 123
Colt "Banker's Special" Revolver, 119, 157
Colt "Camp Perry Model" Pistol, 24, 41, 45, 169, 197

Colt "Detective Special" Revolver, 120, 121
Colt Model 1917 Army Revolver, 83, 84
Colt "New Service" Revolver, 51, 82, 176
Colt "Officer's Model" Revolver, 44, 45, 159
Colt "Official Police" Revolver, 44
Colt "Pocket Positive" Revolver, 117, 118
Colt "Police Positive" Revolver, 118, 119, 120
Colt "Police Positive Special" Revolver, 121
Colt "Police Positive Target" Revolver, 40, 41
Colt Positive Lock, 46, 206, 444
Colt "Shooting Master" Revolver, 51, 160
Colt "Single Action Army" Revolver, 75-80
Colt "Super .38" Automatic Pistol, 97-102
Colt "Woodsman" Pistol, 9, 33, 41, 59, 60, 159, 169, 487
Colt's Patent Firearms Mfg. Co., 3, 16, 33, 66, 217
"Conlin Model" Pistol, 18
Corrosion, 222
Crossman Air Rifle, 11-12

D

Dalrymple, Bud, 209
Deming, Capt., 525
"Destroyer" Revolver, 138
"Detective Special" Revolver, 120, 121, 128, 156
Detonation, 215
Deutche Waffen und Munition Fabriken, 102
"Diamond Model" Pistol, 18
Dillinger, John, 515
Dimensions, Barrel, Table, 145
Dimensions, Bore & Groove, 34
Disarming a Criminal, 494, 495, 500, 501, 504, 505, 510
Double Action, 3
Drift of Bullet, 142
Drop of Bullets, 312, 314
Drop, Table of, 317
Dry Shooting, 461
Dunbar, R. J., 478
Duquesne, Fort, 414

E

E. C. Powder, 396
Echeverria, 139
Eibar, Spain, 135, 138, 139
"El Tanque" Revolver, 137
Energy, 317, 408
Energy Factor, 319
Englebrecht, j.j., 477
Erosion, 222
Exterior Ballistics, 309

F

Fabrique Nationale d'Armes de Guerre, 133
"Fanning" the Hammer, 76
Federal Firearms Act 16, 209
Filmkote Ammunition, 400
Fiala Pistol, 2
Firing Pin Action 167, 168, 169
Firing Pin Blow, 164
Firing Pin Blow, Table of, 166
Firing Pin Shape, 169
Flinching, 465, 469
Foiling an Attempted Holdup, 512
Form Factors, Table of, 313
Frank, M. E., 466
Free Pistols, 36, 37, 200
French Automatic Pistols, 134
From, F. L., 478
Furst, R. S., 478

G

"Gadgets," 449
Gau, Lieut. Lawrence H., 449, 495, 500, 501, 504, 505, 510
Gilding Metal, 280
Glasses, Shooting, 254
"Gould Model" Stevens Pistol, 18
Government Automatic Pistol, 91-95
Grip Adapters, 260, 261
Grips, 28, 31, 201
Grip Safeties, 94, 104
Groove Dimensions, 34
Gustin, C. P., 478

H

Haenel Air Pistol, 13
Hammer-the-Hammer Safety, 54, 206, 444
"Hand" of Revolver, 163
Harrington, John M., 26, 58
Harrington & Richardson Arms Co., 3, 16, 115, 395
H. & R. "Handy Gun" 15
H. & R. "New Defender" Revolver, 56, 121, 158
H. & R. "Sportsman" Revolver, 55, 56, 228
H. & R. Safety Cylinder, 57, 58
H. & R. ".22 Special" Revolver, 53, 55
H. & R. U. S. R. A. Model Pistol, 26, 28, 169, 196, 202, 245, 453
Harper, Frank S., 517
Hartmann-N. R. A. Carrying Case, 247
Hartmann Trunk Co., 247
Hatcher, Major Julian S., 148, 152, 468, 477
Hatcher, Robert D. Frontispiece, 99, 208
Headspace, 167
"Hi-Hold" Grip, 54
Hi-Standard Automatic Pistol, 60, 63
Hip Shooting, 489
Holsters, 240-246
Home Protection, 508
"Hogan's Alley" 524, 525
Housing, Main Spring for Woodsman, 62
Hubertus Air Pistol, 14, 15
Hudson, Dr. 229
Hudson's Cleaner, 229

I

Interior Ballistics, 287
Ithaca Autoburglar Gun, 16
Iver Johnson Arms & Cycle Co., 16, 115
Iver Johnson Hammer-the-Hammer Safety, 54, 206, 444

Iver Johnson Hammerless Revolver, 114
Iver Johnson "Protector" Revolver, 122
Iver Johnson "Supershot Sealed Eight" Revolver, 52, 53, 228

J

Jacketed Bullets, 398
Japanese Nambu Pistol, 111, 112
Jensen, Sgt. J. B., 477
Jones, Henry P., M. E., 258
Jones. Col. Roy D., 172, 395, 466
Jorgensen, S. J., 478
"Jump" 156, 300
"Jump" of revolvers, Table, 304
Justice, Department of, 515

K

K—.22 Revolver, 42, 43, 146, 159, 220, 390, 395
Keith Bullet, 48
Keith, Elmer, 77
Keyes. Geo. H., 455
King Sights, 481

L

La Garde. Col. 413, 417, 418, 420, 424, 427, 433
Langrish Limbless Target, 522
Lead Plate Tests, 416
Lead, Shaving of, 162
Leading, 224, 225
Learning to Shoot, 439
Lee, T. K., 20
Lesmok Powder, 231
Liége, Belgium, 133, 134, 135, 238
Life of Barrel, 222
Lock Time. 197
Long Range Shooting, 490
"Llama" Pistol, 139
Lubaloy, 399
Luger Carbine. 106
Luger Pistol, 98, 102, 103, 487
Luger Ballistic Data, 335
"Luna" Pistol, 36

M

McGivern, Ed, 78, 486
Machine Rest, 27, 33, 43, 170, 171
Machine Rest Groups, 148, 149
"Magnum" Revolver. Frontispiece, 48, 49, 158, 159, 160
Mann, Dr. F. W., 170, 171, 172
Mann Rest, 170
Martin, J. H., 244
Mauser Automatic Pistol, Military Model 5, 106, 107
Mauser Pocket Automatic Pistol 131, 132
Marksmanship School for Police, 520
Mechanical Difficulties, 219
Military Arms, 8, 75, 91
Military & Police Revolver, 40, 116
"Model of 1909" Revolver, 82
"Model of 1917" Revolver, 83
Momentum, 433
Moore, F. T., 217

N

Nagant Revolver, 332
Nambu Automatic Pistol, 111, 112
National Matches, 477
National Rifle Association of America, 192, 247, 477, 520, 523, 525
Ness, F. C., 148
"New Century" Model Revolver, 83
"New Defender" Revolver, 56, 121, 158
Newman, John, 78
Newman, L. Cloud, 415
New Service Revolver, 51, 82, 176
Nitro-Solvent Formula, 229
Nobeloy, 399
Noel, Albert, 268
Non-corrosive Primers, 223
Nowka, R. J., 477

O

Oberndorf, a/N 131
"Officer's Model" Revolver, 44, 45, 159
"Official Police" Revolver, 44
"Offhand" Model Stevens Pistol, 19
"Olympic" Model Pistol, 20, 160
O'Hare, P. J., 252
Ortgies Automatic Pistol. 132
Orthoptic Spectacles, 256
Outdoorsman's Guns, 8

P

Pachmayr Adapter, 261
Pachmayr, Frank, 261
Paine, Chevalier Ira A., 177
Paine Sight, 18, 177, 179
Pale, Paul, 478
Parker, A. G. & Co., Ltd., 252, 267
Patridge, E. E., 178
Patridge Sight, 178. 179
Payroll Robberies, 506
Peace Officer, the, 514
Pedersen, J. D., 127, 204, 400
Peep Sights, 181
Penetration, 319
Penetration, Tables of, 321
Peters Cartridge Company, 86, 400
Pickrell, R. G., 478
Pieper Automatic Pistol, 134
Pieper, H., 134
Pieper, Nicholas, 134
Pistols, Single Shot, 1, 18
Pocket Automatic Pistols, 123
"Pocket Positive" Revolver, 117, 118
"Police Positive" Revolver, 118, 119, 120
"Police Positive Target" Revolver, 40, 41
"Police Positive Special" Revolver, 121
Police School, 520, 523
Police Training, 519-526
Positive Lock, 46, 206, 444
Powders, 279
Practical Shooting, 479
Pressure, 288, 386
Pressure Gage, 387
Primers, 283
Primers, Non-corrosive, 223
Primer Compounds, 283-285
Proof Marks, 236, 238

R

Radius, Sight, Table, 187
Rapid Fire, 473
Rathberg, Hans, 285
Range, Constructing, 262

Recoil, 155, 300, 305
Recoil Tables, 308
Remington Arms Co., 285, 358, 391, 398
Remington Automatic Pistol, 127, 128, 204, 487
Renshaw, Lieut. Harry N., 32, 149, 152
Rest, Machine, 27, 33, 43, 170, 171
Rest, Receiver and Forearm, 174
Rest, Six Point, 173
Revilliod de Bude, Mr. A., 456, 457
Revolver Vs. Automatic Pistol, 5
"Rifleite" Shooting Glasses, 253
Rifling, 142
Rifling, Twist of, Table, 144
Riedell, W. F., 478
Rod, "Range" or "Lining," 164
Rods, Cleaning, 253-255
Roberts, L. K., 478
Roper, Walter, 26, 27, 32, 56, 148, 202, 203

S

Safety Cylinder, 57, 58
Safety Device, 54. 46, 205
Safety Hammer Block, 206, 444
Safety Precautions, 442
Samworth, Thomas G., 224, 483
Sayers, Clyde J., 477
Savage Automatic Pistol, 126
Schwab, W. C., 478
Searles, Major, 126
Sectional Density, Table, 313
Sedgeley, R. F., 267
Selecting a Gun, 231, 440
Self Defense, 492-510
Set Triggers, 197, 198
Shape Factor, 431
Sharpshooter Powder, 354
Sharp Shoulder Cartridges, 121
Shaving Lead, 162
Shock Power, 401-435
Shooting Glasses 254
"Shooting Master" Revolver, 51, 160
Shot Cartridges, 209
Sight Adjustment Tables, 34, 57, 187
Sight Changes, 470
Sight Radius, 17
Sight Radius, Table of, 187
Sighting, 458
Sighting Triangles, 50, 51, 460
Sights, 175-191
Sights, Call, 181
Sights King Ramp-Red-Bead-Reflector, 181
Sights, Paine, 177, 179
Sights, Patridge, 178, 179
Sights, Peep, 181
Silencers, 208
Sillin, Lieut. N. D., 453
Single Shot Pistols, 1, 18
Single Action Army Revolver, 75, 77
Six Point Rest, 173
Slip-Hammer Gun, 78
Slip Shooting, 77
Slow Fire Shooting, 465
Smith, William T., 246
Smith & Wesson, 16. 163. 175, 325
S. & W. Army .38 Revolver, 80
S. & W. Automatic Pistol, 97
S. & W. .44 Military Revolver, 46, 82
S. & W. .44 Target, 46
S. & W. Hand Ejector Revolver, 115, 116, 493
S. & W. K-.22 Revolver, 9, 42, 43, 146, 159, 220, 390, 395
S. & W. Military & Police Revolver, 40, 116
S. & W. Model 1917 Revolver, 83, 84
S. & W. New Century Revolver, 83
S. & W. Perfected Single Shot Pistol, 19, 37, 451
S. & W. Safety Hammerless Revolver, 113, 114
S. & W. Regulation Police Revolver, 115
S. & W. Straight Line Pistol, 21, 22, 246
S. & W. .22/32 Heavy Frame Revolver, 39, 43, 159
S. & W. .38/44 Heavy Duty Revolver, 47, 48
S. & W. .38/44 Outdoorsman's Revolver, 9, 46, 156, 160
S. & W. .357 Magnum Revolver, 48, 49, 156, 159, 160
S. & W. Triple Lock Revolver, 83
Snapping Practice, 461
Speed Shooting, 78, 485
"Sportsman" Revolver, 55, 56, 228
Spanish Pistols, 139
Springfield Rifle, 5
Stability of Bullets, effect of, 412
Stainless Steel Barrels, 225
"Star" Pistol, 139
Stevens Arms Co., 18
Stevens Pistols, 18, 19, 451
Stoeger, A. F., Inc., 10, 38, 105, 108, 267, 104
Stopping Power 401-435
Stotzer Perfekt Pistole, 37, 38, 200
Strength of Weapons, 213
Sub-caliber Devices, 266
Sullivan Act, 497
Super Police Cartridge, 346, 353
Supershot Sealed Eight Revolver, 52, 53, 228
Sweet, W. H., Capt., 489

T

Target Arms, 8. 17. 38
Target Revolvers, 38
Target Shooting, 17
Technical Notes on Weapons, 141
Telescopes, 257
"Tell" Pistol, 36, 452
Thomas, John M., 95
Thompson, Col. John T., 418, 433
Thompson Sub-machinegun, 10, 418, 507
Time in Barrel, 289
Tippins, Mr., 466
Topperwein, Ad., 224
Training School for Police, 519
Trajectories, Comparative, 99
Trajectory, 310, 311
Trask, Stephen, 420
Trigger Pull, 17, 191
Trigger Pull, Adjusting, 193
Trigger Stop, 194
Trigger Weights, 265
Tryon, Edw. K., 246
Twist of Rifling, Table, 144

U

Upshaw, G. M., 478
U. S. Cartridge Co., 285

U. S. Revolver Association, 191, 192, 476, 478
U. S. R. A. Model Single Shot Pistol, 26-35, 169, 196, 202

V

Valdes, Antonio, 497
Van Asbroek, Paul, 257
Velocity, 290, 390, 405, 427
Velocity Measurements, 309
Velocity Curves, 154, 294, 296, 298
Velocity, Comparative, Tables, 87, 154, 155, 299
Villar Perosa Sub-machinegun, 3
Vickers Rifle, 34
Von Hertz, Edmund Ritter

W

Wad Cutter Bullets, 398
Walther Automatic Pistols, 130
Webley Air Rifle, 11
Webley Air Pistol, 12, 13
Webley & Scott, Ltd., 16, 267.
Webley-Fosberry Automatic Revolver, 90
Webley Mark IV .22 Revolver, 59
Webley Mark VI .38 Revolver, 89
Webley Mark VI .455 Revolver, 88
Webley "M.P." Automatic Pistol, 129
Webley New Military & Police Pistol, 129
Webley Pocket Automatic Pistol, 129
Webley Self Loading Pistol, .455, 109
Webley Single Shot Target Pistol, 35, 169
Weight of gun, 159
Weights, trigger, 265
Wesson, Major Douglas B., 42, 46, 48, 146, 224, 390, 391, 395
Western Cartridge Co., 346, 348, 353, 391, 399
Ward, C. E., 477
Widmer Pistol, 37, 452
Wollensak Telescope, 257
Woodworth, Capt. A. L., 20, 65, 172
Woodworth Cradle, 172
Wounds of Entrance and of Exit, 511
Wright, W. A., 259

Y

Yaw, 433
Young, Capt. J. E., 478

Z

Zella-Mehlis, Germany, 36, 131

This book is one of a series published by
The Small-Arms Technical Publishing Company

a company which publishes only the best of technical works devoted to the subject of firearms, shooting, ballistics and allied subjects.

The authors of these books are unquestioned authorities in their specific field who are encouraged and aided in making their book the outstanding work of its kind.

As the selling field for such books is highly specialized and is confined mainly to the rifle, pistol and shotgun shooters, as well as to sportsmen in general, the Company's efforts toward promoting and selling its books are confined to a direct mail order business. It delivers its books by mail or express directly into the hands of its customers. Consequently it is enabled to turn out books which, as to size, number of pages and illustrations, binding and general completeness of subject, will be found the equal or superior of similar competitive works selling at twice their price.

The Company brings out new books from time to time, therefore it is suggested that the reader send in his name and address to be placed on the mailing list; also the names of such friends who may be interested in the subject of firearms and their use.

The Small-Arms Technical Publishing Company
Plantersville, South Carolina

Their Publications to Date Have Been:

HANDLOADING AMMUNITION,
By J. R. Mattern

WILDERNESS HUNTING AND WILDCRAFT,
By Townsend Whelen

SMALL BORE RIFLE SHOOTING,
By Edward C. Crossman

PISTOLS AND REVOLVERS AND THEIR USE,
By Julian S. Hatcher

MODERN GUNSMITHING,
By Clyde Baker

MODERN SHOTGUNS AND LOADS,
By Charles Askins

THE BOOK OF THE SPRINGFIELD,
By Edward C. Crossman

MILITARY AND SPORTING RIFLE SHOOTING,
By Edward C. Crossman

.22 CALIBER RIFLE SHOOTING,
By Charles S. Landis

TEXT BOOK OF PISTOLS AND REVOLVERS,
By Julian S. Hatcher

Similar works are in course of preparation